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STUDIES ON PLANT CANCERS—II

THE BEHAVIOR OF CROWN GALL ON THE RUBBER PLANT (*FICUS ELASTICA*)[1]

(WITH PLATES 1 AND 2)

MICHAEL LEVINE

Toumey (1900) in studying the effects of crown gall on the host pointed out the destructiveness of this disease on deciduous trees. He gave an adequate picture of the developmental stages in the growth of the crown gall tissue on the almond. He contends that the period of growth of the crown gall is definite and usually extends over the growing season; after which time the gall dies, falls out, leaving an open wound. In the following spring a new crown gall is formed on the margin of the old wound which in turn dies and increases the area of the lesion, so that it weakens the tree and causes it to break off in a wind, thus killing it. It appears from Toumey's study that death is the result of a mechanical effect of the crown gall on the tissue of the host in no way similar to the toxic effects that the cancerous growth has on the animal or human being.

Hedgcock (1910[1]) in his field studies of the effect of crown gall on grape showed that the crown gall stunts the plant and that when the galls occur on the stem under the ground they commonly decay, killing the adjacent tissue and often killing the vine above the point of attack. Whether the decay is directly brought

[1] From the Cancer Research Laboratory, Montefiore Hospital, Dr. Isaac Levin, Chief. The first paper was published in Bull. Torrey Club 46: 447–452. *pls. 17, 18.* 1919.

[MYCOLOGIA for November (12: 299–360) was issued December 27, 1920]

about by *Bacterium tumefaciens* Hedgcock does not state. He claims however with Toumey that the galls die annually. In a later study (1910[2]) of crown gall on the apple he maintains that the destructive effect of this disease is overrated.

Smith (1911–12) in his extensive studies on crown gall and its resemblance to animal cancer shows that the physiological effects of these tumors vary from species to species and also within the species and are generally less pronounced and speedy than one might expect. He holds that it is difficult to show conclusively that the substances produced in the tumor by the parasite are absorbed and act as slow poisons. This is especially difficult in view of the fact that the galls are often soaked by rains and become infected with other parasitic and saprophytic organisms.

Levin and Levine (1918–20) in a report on the malignancy of the crown gall and its analogy to human cancer pointed out that a number of the phenomena in both diseases are analogous. They contend that the neoplasms in plants produced by *Bacterium tumefaciens* are sometimes benign though some are true malignant growths. The latter generally dwarf the plant so affected and cause necrosis of the tissue above and below the gall.

These studies and those of Smith's and other workers were carried out in annuals, biennials or deciduous trees in which the period of growth of the host as well as the crown gall is normally interrupted. The difficulty in determining whether toxins are present in such cases is made more difficult by the intervention of natural death, caused by changes in temperature and its concomitant factors, and second, by the occurrence of infections caused by fungi and even insect grubs, the eggs of which are deposited in the soft tissue of the young crown gall.

The purpose of this report is to bring forward further evidence on the malignancy of the crown gall experimentally induced on mature evergreen perennials such as the common rubber tree, *Ficus elastica.* In such plants where the growth is rather active all the year round, when kept under uniform, green house conditions, the effect of the crown gall organism and the neoplastic growth on the host can be kept under observation for an extended period. Drenching rains and destructive insects are

avoided and very often other parasitic and saprophytic fungi. In this way and in such plants as *Ficus elastica* it is possible to show definitely whether and in what degree the crown gall has an injurious effect upon the adjacent normal tissue of the host. It must be remembered however that while transportation of the materials elaborated by the cancer cells of the animal is in some degree limited, this is much more the case in plants.

I have found some evidence of injurious effects spreading from a gall upwards and finally killing the stem above the point of inoculation. This was the result in every case (10 branches) with two exceptions. In the first the signs of death are only now, 14 months after inoculation were made, making their appearance. In the other case described below, the stem, it appears, was cut off for examination too soon.

In no case was there any evidence that the death of the stem above the gall was due to the obstruction of the sap flow or water supply. Toumey's results do not suggest the possibility of any such direct mechanical disturbance on the part of the gall. I will describe briefly a number of cases observed.

Material and Observations.—Through the courtesy of Dr. S. Wachsmann, director of the Montefiore Hospital, a number of rubber trees (*Ficus elastica*) were placed at my disposal. These plants were growing in large boxes and were kept indoors during the winter months in a basement room well lighted and ventilated. In the summer these plants were moved out on the campus of the hospital. These plants make almost as much growth during the winter as they do during the summer. Various parts of these plants were inoculated with *Bacterium tumefaciens,* labeled and then examined from time to time. It was found that within a month indications of a crown gall made their appearance in the part of the plant inoculated.

Figure 1 represents one of the trees during the month of January used in this study. The terminal buds are opening and the moderately green glistening apical leaves show evidence of an active condition of growth. The plant shown in figure 1 with five others of equal size were inoculated on July 28, 1919, by pricking the tissue with a steel needle that had been previously

dipped into a culture of *Bacterium tumefaciens.* As few as five pricks of the needles with the crown gall organism were found to be sufficient to produce a visible neoplasm in a month's time. A careful scrutiny of this picture reveals a number of galls at the internodes of several branches (Fig. 1, *a, b*) on the mid-vein of an old leaf (Fig. 1, *c*) and on one of the main branches (Fig. 1, *d*). Where the needle perforated the tissue a crown gall was formed on both sides of the stem or the leaf. No less active were the growths that were produced on the trunk of the tree (Fig. 1, *d*). The galls formed are of the characteristic type described by Toumey, Smith and others. They are always firm, yellowish in color and covered with brownish patches when young and become dark brown in color and of a woody consistency with age, as we shall see below.

The crown gall, at this stage, as far as can be seen, has no specially injurious effect upon the host. The terminal buds of the plant are actively growing and there appears to be no signs of dwarfing of the branches, nor any indication of fascination of the internodes above the region of inoculation such as those reported by Smith, and Levin and Levine for *Geranium, Ricinus,* etc.

Figure 2 represents a branch from another rubber tree which had been inoculated seven months previously on the second internode. The crown gall has grown extensively, covering one half of the circumference of the stem. The surface is dark brown in color, highly convoluted, indicating a number of centers of peripheral growth. The mass is hard and some parts of the surface appear to be dead. The branch however has grown considerably as shown by the number of internodes above the crown gall. (See Figs. 2 and 3.) In June, 1919, it was noted that the terminal bud was small and dark green in color, and showed no signs of growth. This was true of a number of other branches which had been inoculated for the same length of time. The control branches that were similarly treated with a sterile needle had long greenish buds, many of which were opening. This condition suggested at once the possibility of mechanical interference of the crown gall with the water supply of the plant due to partial destruction and possible occlusion of the fibrovascular bundles,

but cross and longitudinal sections of this gall made much later showed this assumption to be incorrect as is further described below. It is obvious at once however that there is some other cause of death than the cutting of the water supply, since in that case, the dying would progress from the tip downward.

Twelve months after inoculation. Figure 3 represents the same branch shown in figure 2 on December, 1919, approximately 12 months after the inoculation had been made. The crown gall has almost girdled the stem encircling 7/8 of the stem's circumference. The leaves above the crown gall have turned black and fallen off while those below are turning a yellowish brown. The major portion of the stem above the gall is dead, the injury progressing from the gall upward so that at the time the photograph was made the top of the stem (Fig. 3) was still green and showed indications of being alive. A cross section through the middle of this crown gall appears in figure 4 and shows that the crown gall tissue has become fully differentiated and thus further supports the contention of Toumey and Hedgcock that the crown gall growths are annual and Levin and Levine's views that these growths are unlike animal cancers in that they are limited in growth and become differentiated. The wood fibers and parenchymatous cells of which the crown gall is composed are dark brown on the interior of the gall as they are on the surface. The vascular elements are distorted and nodular on the periphery of the tumor where their antecedents were undoubtedly centers of rapid cell division before they became differentiated and old.

Approximately one half of the original cylinder made by the fibrovascular bundles is destroyed and replaced by crown gall tissue. The tissue in the center of the crown gall is dark in color, watery and is apparently disintegrating. The remaining half of the wood cylinder appears to be undistributed and undoubtedly is mechanically fit to carry sap, as evidenced by the still turgid condition of the top of the branch as shown in figure 5. This figure represents a longitudinal section of the upper part of the stem including the upper part of the crown gall. There appears to be only a partial destruction of the wood fibers in the region of the stem occupied by the lesion as seen in the

cross section to the left of the figure. The wood and pith are apparently normal structurally though physiologically dead.

A later state in the necrosis following the inoculation of *Bacterium tumefaciens* is shown in figure 6 photographed eleven months afterward. Here again the inoculation was made at one side of the stem in the third internode with a needle dipped into an emulsion of the crown gall organism. In this late stage the growth does not completely girdle the stem, yet two months previously the leaves fell off and the stem became discolored and finally died. The crown gall and the stem above the gall also died. A short portion of the stem immediately below the gall at the time of the photograph was rapidly undergoing similar changes. The gall in this case again shows all the characteristics of the typical crown galls referred to above. The outer surface is dry and woody and is markedly nodular. In a longitudinal section of this gall we find the region near the stem slightly moist, darker in appearance and invading the wood cylinder (Fig. 7). A large portion of the wood cylinder is intact and appears to be functional. There again, it appears as if death was caused by *Bacterium tumefaciens* or the crown gall cells rather than by the interference with the transportation system caused by the destruction on the invasion of the fibrovascular bundles.

Figure 8 represents a gall 12 months old which has caused no injury to the stem either above or below the gall. Growth is continuing normally. The inoculation was made in two opposite sides of the branch. The crown gall that appears in front on the stem "B" and "C" was produced by inoculating an axillary bud region. The lower gall, "A," was obtained by inoculating an internodal space on the opposite sides of the stem. The lower growth which appears as two separate tumors on opposite sides of the stem consists of one continuous mass of tissue encircling one half of the circumference of the stem. The growth has a distinctly tubercular structure. It is dark brown in color, hard and dry, and apparently dead. The upper crown gall which is on the surface of the stem, as mentioned above, extends for a distance of nearly one half of the circumference of the stem also. To the left it developed into a more or less uniformly globular growth through which two branches have grown.

We may turn now to consider the cases in which no evidence of injurious effects of the gall in tissue above and below it in the stem have yet appeared. In all, I have observed two such cases as mentioned above against ten in which death of the region above and below the gall or both occurred.

It is natural to suspect in view of the statements of the authors quoted that the injurious effects I have observed may be due to the presence of some additional infection or to some special direct physical effect of the crown gall on the rubber tree. I am however convinced that this is not the case.

As in the case of *Bryophyllum* (Levine 1919), *Bacterium tumefaciens* does not cause the formation of embryomata when inoculated into *F. elastica* in a region where embryonic cells are to be expected. At the time this photograph was made, twelve months after inoculation, the upper gall was still active although parts of it were beginning to distintegrate. The stem above the gall appears as noted to be entirely unaffected and in good physiological condition. A cross section of the stem made at the level indicated by the line "AA" shows complete disorganization of more than one half of the wood cylinder. The remaining half is not unlike the apparently healthy portion of the wood shown in figure 4. A photograph of the cut end of the stem at the level of "BB" (Fig. 8) is shown in figure 9. Here little of the vascular cylinder appears to be invaded by the crown gall tissue. At this level the great mass of the crown gall seems to have developed from the cortical layer of the stem only and has not, at this time, affected the central cylinder.

The gall from which the branches "Y" and "Z" appear (Fig. 9) is unlike all other crown galls so far described in that almost its entire surface is smooth and not tubercular; it is covered with small brown corky patches. The lower left side of the gall in the picture shows the typical crown gall convolutions.

A section still higher up on the stem made at the level indicated by the line "CC" cuts through this smooth gall at a point near the origin of the branches "Y" and "Z" (see Fig. 10). An abundance of milk comes from the entire surface above the dark area of the crown gall shown in this figure. No invasion

of the central cylinder by the crown gall tissue appears. There is, however, a slight hyperplasia of the wood. The fan-shaped vascular elements in the gall seem to be running into the branches "Y" and "Z" from "X." The gall in this case may be compared to the so-called benign tumors (Levin and Levine, 1918). The character of the tissue of this neoplasm does not differ from that of a malignant crown gall. It seems obvious that the death of the crown gall is in general a result of merely mechanical conditions. The gall may be insufficiently supplied with food and water and dies because it fails to establish an adequate connection with the conducting system of the host. It is most likely that this is true of the almond crown gall described by Toumey.

Bacterium tumefaciens from stem and crown gall. The possibility that another organism as well as *Bacterium tumefaciens* is present and is responsible for the destruction of the stem apex as shown in figures 3, 5, 6 was tested in the following manner. Small pieces of the interior of the crown gall shown in figures 3 and 6 were carefully removed with a sterile knife and placed in tubes of beef agar. In two days the surfaces of the agar on which the inocula were resting became covered with a hyaline, whitish yellow colored schizomycete which in general appearance is not unlike that of *Bacterium tumefaciens*. Similar results were obtained by planting pieces of the stem from above the crown gall after being superficially sterilized by immersing in a weak formol solution. In all tubes the organisms were more or less alike in their superficial appearance. In several beef agar cultures the hyphae of a mold made their appearance. The presence of the mold we consider accidental contamination. Molds at any rate are not known to be parasitic on and to cause death of the rubber tree.

It appears from this that the organism is carried to parts removed from the gall but owing to its depauperate condition is unable to influence the production of a new growth.

The organism obtained in these cultures were inoculated into the tissue of young growing geranium plants and young shoots of the rubber trees. Crown galls appeared within two months after inoculation. The growths were much smaller than those

obtained by inoculating young geraniums and branches of a rubber tree with a known culture of *Bacterium tumefaciens.* This supports the contention that the bacteria in the distant parts of the stem bearing a crown gall are of a less virulent strain.

SUMMARY

1. *Bacterium tumefaciens* inoculated into the apical internode of the branches, into the leaves, or main stem of the rubber tree, *Ficus elastica,* stimulates the development of a neoplasm in the region of inoculation of a benign or malignant nature. The crown galls so formed, in this plant, are of two kinds, one in which growth is uniform and appears to be a swelling, the other is the characteristic convoluted type indicating a peripheral growth of isolated nodules.

2. The early stages in the development of the crown gall in *Ficus elastica* does not interfere with the life of the plant as a whole nor does it interfere with the growth of the inoculated branches.

3. The crown gall in *Ficus elastica* after a number of months of active growth becomes hard and dry and finally dies. This is associated with the differentiation of the tissue which converts the gall into a mass of parenchymatons cells and nodules of woody fibers. The central portion of the crown gall which generally lies near the woody cylinder disintegrates.

4. The invasion of the stem by the new growth does not destroy the entire conducting system of the stem, yet that portion of the stem above the gall dies as well as considerable portion of the stem below.

5. Cultures made from pieces of the crown gall and stem above the gall yield only a schizomycete which in appearance is not unlike *Bacterium tumefaciens* and which when inoculated into the stem of young geranium and rubber plants produce crown galls in the region of inoculation.

6. It is possible that the crown gall cells or the crown gall forming organisms are responsible for the progressive necrosis of the stem from the gall upward and downward. The death of the plant due to crown gall is at least suggestive of the death caused by malignant growths in animals.

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EXPLANATION OF PLATES 1 AND 2

Fig. 1. Represents the type of *Ficus elastica* used in these experiments. The galls in the various parts of the plant *a*, *b*, *c*, and *d* are the result of inoculating them with a culture of *Bacterium tumefaciens*, five months previously.

Fig. 2. Apical portion of a branch showing a large crown gall seven months after inoculation in the second internode. The gall does not seem to have interfered with the growth of the stem; several internodes having been added in the interim. (× ½.)

Fig. 3. Same branch twelve months after inoculation. The leaves above the gall have dropped off. The stem is discolored, dry, and dying progressively upward. The tip is still green and alive. The gall is hard, dry and dead. (× ¼.)

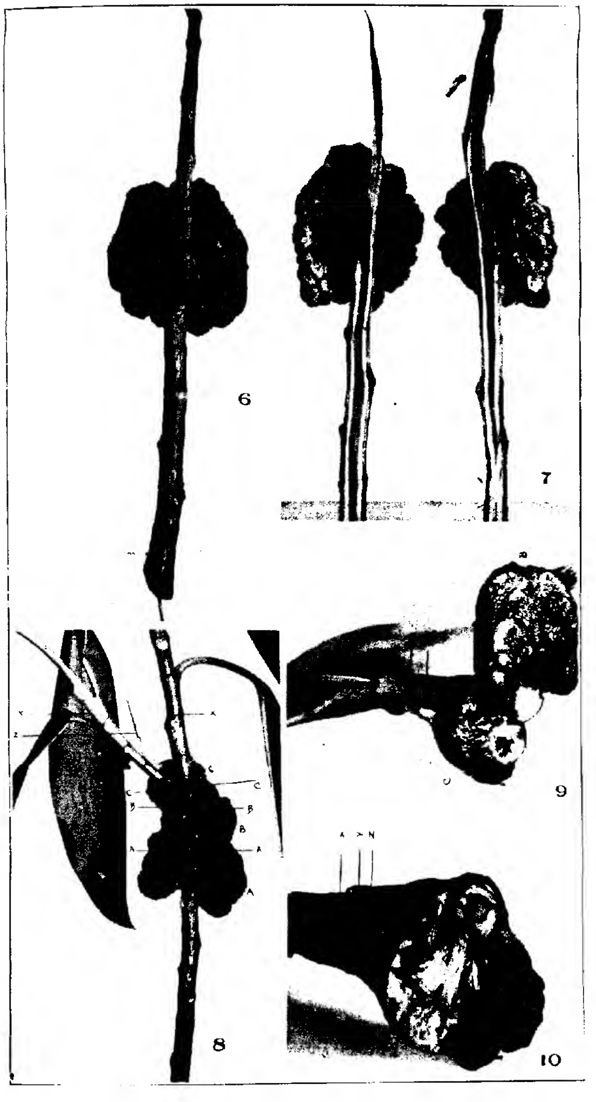
Fig. 4. Cross section of the stem through the gall shown in figure 3. The wood cylinder is only partially destroyed by the invading gall. The portion of the crown gall near the central cylinder is soft and disintegrating.

Fig. 5. Longitudinal section of the upper portion of the same stem. The portion near the gall is dry, brown and dead, while the apical internode and bud are still green and alive.

Fig. 6. A branch of *Ficus elastica* in which the gall and the stem above and below the gall is dead; the inoculation having been made twelve months previously.

Fig. 7. Longitudinal section showing invasion of the crown gall destroying a considerable portion of fibrovascular bundles. The invading portion of the gall is soft, spongy and disintegrating.

BACTERIUM TUMEFACIENS ON FICUS ELASTICA



BACTERIUM TUMEFACIENS ON FICUS ELASTICA

Fig. 8. A branch of *Ficus elastica* actively growing twelve months after having been inoculated with *Bacterium tumefaciens*. Two galls formed "A," and "B," "C," on opposite sides of the stem showing the smooth and nodular types of crown galls. Two branches are growing through the smooth crown gall.

Fig. 9. Cross section of stem between the upper and lower crown galls corresponding to level indicated by the line "BB" in figure 8. The gall to the left is of the smooth kind, being covered by corky patches.

Fig. 10. Cross section higher up on the stem corresponding to the level indicated by the line "CC" in figure 8. Shows large brown necrotic area and the undisturbed cylinder of the main stem "X" with bundles of fibers going to branches "Y" and "Z."

NINETEEN YEARS OF CULTURE WORK[1]

J. C. ARTHUR

A series of culture experiments with the Uredinales was begun by the writer in 1899, and continued under the auspices of the Indiana Agricultural Experiment Station without interruption until 1917, making nineteen consecutive years in which this method of research was consistently pursued. The results of the work were embodied in fifteen reports, printed in the Botanical Gazette, Journal of Mycology, and Mycologia. It is now proposed very briefly to review the work, in order to set forth some of the objects accomplished, and especially to point out the more important of the changing conceptions of the problems forming the ground plan on which the work was projected.

The cultures were not undertaken as part of a distinct thesis or circumscribed problem. They were rather the aids in a general taxonomic study of American rusts, which was directed toward supplying a technical description as complete as possible for every species of Uredinales in North America recorded in literature or known to the writer. This ambitious undertaking was definitely begun sometime in the nineties at the invitation of the editors of the North American Flora.

Beginning with my first taxonomic work on the rusts in 1882 it had seemed to me highly desirable for the purposes of a full technical description of species, that every part of these microscopic plants, capable of supplying diagnostic characters, should be uniformly considered, quite as much as are the stems, leaves, inflorescence, flowers, and fruit of higher plants, and that every means should be taken to arrive at a clear understanding of the identity and relationship of the various forms and species. No effort should be spared, it was believed, to make the name applied to any form embrace also the transformations and variations

[1] Contribution from the Botanical Department of Purdue University Agricultural Experiment Station.

which that form undergoes in passing through its whole life cycle. Many rusts are commonly collected in only one or two stages of their development, or the several stages are taken as independent objects, and to grow such rusts so as to keep them under direct observation and be able to note the succession of stages seemed highly desirable, and especially so for the heteroecious species which pass their gametophytic and sporophytic stages upon wholly unlike and unrelated hosts. It was natural, therefore, to direct chief attention, especially at first, toward unraveling the tangle of heteroecious forms.

Nobody knew how many rusts were to be found on the North American continent and its islands. There were possibly a thousand or more names in existence, but how many of these names applied to single and independent life cycles, and how many to parts of cycles, or were synonyms, no one had attempted to say. It was, in fact, only with the existing names that I had to do. It was no part of my problem to discover new species, or to give new names, either in preparing manuscript for the North American Flora, or in conducting cultures, except in so far as these were required for the systematic development of the work. Many longer or shorter excursions were made during the progress of the cultures, some of them a thousand miles or more, but they were all for the purpose of making field observations upon known species, and in no case for making discovery of new species. The new species that were found were an incidental result.

The first year of the culture work, that of 1899, was very encouraging, and developed no particular difficulties calling for solution. So far custom was followed in the application of names, and it had not been necessary to apply any formula to decide what constituted a species. The assumption that forms on the same or closely related hosts, having no striking morphological differences, were of one species seemed a sufficient hypothesis, and the corollary necessarily followed that cultures would show the range of hosts for each species, as well as serve to demonstrate the stages and spore-forms in the life cycle. Certain features in connection with the common Euphorbia rust did indicate that difficulty might be found in the application of the

corollary, and this indication became more pronounced during the year following.

In 1902 three species of Euphorbia of unlike appearance and growth habits were found to bear non-interchangeable rusts, which were tentatively considered to present races of *Uromyces Euphorbiae* C. & P., and with the more confidence because no well-defined morphological distinctions could be detected. Subsequent studies strengthened this view of races, and the idea of races from this time on was constantly kept prominently in mind. The attempt to evade or simplify taxonomic and cultural difficulties by treating such races or biological strains as species, as Tranzschel[2] subsequently did with these same Euphobia forms was not favored.

It was also in 1902 that the Helianthus rust was grown with indication of races, developed further in the following year, and brought to a climax in 1904, with the conclusion that a number of more or less well established races occur in *Puccinia Helianthi* Schw., having *Helianthus annuus* as a bridging species, following the lead of Marshall Ward[3] in his study of the brome rusts. No further considerable effort was made to study races in autoecious species, or to pick out bridging hosts, as it was held that to ascertain the identity of species was as great a task as could be undertaken in this series of cultures, and that studies leading to the separation of a species into varieties, races, forms, or other subclasses, although of much biological and often of great economical interest, must be left for other time and hands.

The problems of the Carex rusts came early into view. In 1901 and 1902 the three remarkable co-species, having telia on various species of Carex and aecia on species of Aster, Solidago and Erigeron respectively were repeatedly grown from telial material, and were called *Puccinia Caricis-Asteris, P. Caricis-Solidaginis,* and *P. Caricis-Erigerontis*. As no single collection of teliospores was found that would infect more than one of the genera named, the forms were tentatively considered to be species and given distinctive names, followng the brilliant cultural methods of Klebahn in Germany, Plowright in England, and

[2] Ann. Myc. 8: 1–35. 1910.

[3] Ann. Myc. 1: 150. 1903.

others, although a careful comparison of the three forms made it seem "not improbable that the three represent more correctly the biological variations of one species," as was stated at the time. In the further study of these forms it was thought that the telial stage might be found to be restricted to certain species of Carex, or to particular sections of the genus, as was believed to be true of the European Carex rusts, which assumption in the case of the American forms, however, could not be established in any definite way. The hosts were shown finally to be even less restricted than supposed, as the Aster form was eventually carried over to Euthamia for its aecia and to Dulichium for its telia.

The necessity soon became acute to find criteria by which to judge of the standing of species among the rusts, and all the more so because the manuscript was now under preparation for the North American Flora. It was soon decided that, for the purposes of the Flora, morphological characters must be the final test for species. Yet for purposes of study outside of taxonomy it might be serviceable and desirable to maintain the so-called biological or physiological species in any rank desired, but they ought not to be recognized as species proper in taxonomic classification. Consequently in 1912 the three Carex forms were combined with certain European forms under the name *Puccinia extensicola* Plowr., a name which has been supplanted by *P. Asterum* (Schw.) Kern, since the cultural series closed. Furthermore, the cultures of 1913 disclosed that *P. vulpinoidis* with its covered telia had its aecia on Solidago, and was a part of this same species heretofore known only with naked sori, making the much emphasized character of covered telia a secondary one to be associated principally with the host.

Thus the idea of species among the rusts grew into a far more definite, although more complex form, than could have been possible without the aid of cultural studies. A liberal view was now also required regarding hosts, and also the stress on certain morphological characters called for modification, but the end was not yet.

In 1910 a number of cultures with the Carex rust, *Uromyces perigynius*, revealed a remarkable parallelism between this species

and *Puccinia extensicola.* Aster and Solidago races came to light, not however quite so well stabilized in some instances as with the corresponding Puccinia races, for in one case sowings of teliospores from the same Carex collection were made to grow on both Aster and Solidago. The two species, one of Uromyces, the other of Puccinia, were subjected to an extensive microscopical study, and no marked differences could be found between their several corresponding spore-forms, except in the septation of the teliospores. This unity of structure had already been observed regarding the aecia and aeciospores when a preliminary culture of the Uromyces was made seven years before. From the microscopical evidence, united with much collateral evidence, the following statement was made in the discussion of 1910, which holds true to the present time: "As the aecia and uredinia of the two groups [of host-races], one under the genus Puccinia and the other under Uromyces, are indistinguishable, and as the teliospores of the Uromyces agree with the one-celled spores of the Puccinia [mesospores] and also with the two-celled spores in all characters except number of cells and consequent length of spore, the former doubtless are morphological races of the latter. Relationship could be shown better by putting all of these forms under one specific name, and designating the several races by varietal names. But in the present state of taxonomy of the rusts it is more convenient to dispose of them under the two genera: *Puccinia* and *Uromyces*."[4]

If any further illustration were needed to show that Puccinia and Uromyces were not only parallel genera but actually identical, it was supplied by the cultures of the following year, 1911. During this season successful cultures on *Atriplex hastata* of both *Uromyces Peckianus* and *Puccinia subnitens,* each grown from teliospores on the grass, *Distichlis spicata,* obtained from widely separated localities, gave rise to aecia that appeared to be indistinguishable. A morphological study of these two so-called species has been reported by C. R. Orton in his article on "Correlation between Puccinia and Uromyces,"[5] in which he finds a

[4] Mycologia 4: 22. 1912.
[5] Mycologia 4: 199. 1912.

slight difference in size of the urdiniospores, and, of course, in the teliospores a difference in number of cells and consequent size. He points out, however, that these differences are such as are to be expected in other similar cases. The comparison of these two forms of Distichlis rust, as to morphology, hosts and distribution, is an interesting topic, which need not be pursued further here.

If the Carex-Aster-Solidago-Erigeron studies supplemented by studies with the Distichlis rust, opened up new views of the species question in relation to host influence and teliosporic dimorphism, so did the Carex-Ribes studies disclose new views in another direction. The first cultures were in 1901. As the results of sowing teliospores on Ribes gave peculiarly small and pale aecia, it was thought that an unrecognized species had been found, which was called *Puccinia albiperidia*. Whether this form was distinct from the common Carex-Ribes rust of the fields, distinguished as *P. Grossulariae*, and whether American forms were distinct from European forms, of which Klebahn had recognized five, were questions which received attention from year to year as opportunity permitted. In this study Dr. Klebahn graciously consented to lend assistance, and during the two seasons of 1904 and 1906 made cultures at Hamburg, Germany, from telial material supplied by the writer.

Just as the problem seemed solved, and Dr. Klebahn[6] and myself had independently arrived at the conclusion that in both Europe and America only one heteroecious species occurred, which possessed a number of strains or races, it was discovered by C. R. Orton,[7] while assisting with the rust studies, that the original material of *P. albiperidia* on*Carex pubescens*, as well as that on a number of American species of Carex similar to *C. gracillima*, possessed urediniospores with only one basal pore, in part at least, instead of the usual three or four equatorial pores. Again the Carex-Ribes rusts of Amercia seemed to fall into two species, not based on differences in the aecia this time, but on differences in the urediniospores. From 1910 onward the question in this connection was whether or not the same species of rust

[6] Zeits. Pflanzenkr. 17: 132–134. 1907.

[7] Mycologia 4: 14, 200. 1912.

could possess urediniospores partly with one basal pore and partly with three or four equatorial pores. The answer involved the value and application of pore characters in defining species. After special search,[8] which led to both kinds of urediniospores being found repeatedly in the same sorus, although for the most part they occurred in separate sori, it was concluded that only one species of rust was under consideration, but with morphological as well as physiological races, not well delimited.

It seemed probable, furthermore, that the previously described, one-pored form of Carex rust, known as *Uromyces uniporulus* Kern, was a race also belonging to the Carex-Ribes species, but it was not possible to test the matter by cultures. In this connection it is interesting to note, and provocative of speculation, that there is no form yet known with three- and four-pored urediniospores belonging under Uromyces in the Carex-Ribes aggregation, to make the parallelism with its Puccinia form complete.

In 1917, the last year of the culture series, the principle of basing species upon morphological characters, with a greater or less degree of mobility in interpretation, was further illustrated by the case of the Spartina rust, *Uromyces Polemonii* (Peck) Barth., which it was found could be segregated into four races,[9] separable by small but appreciable differences in morphological characters of both aeciospores and teliospores, and by wholly unrelated aecial hosts, and further reinforced by some differences in habitat and geographical distribution. The correlated Puccinia-form for this common and widely distributed American rust is that of *Puccinia Distichlidis,* so-called because the type collection was incorrectly labelled as on Distichlis instead of on Spartina. Its range and aecial hosts, so far as known correspond to only one of the four Uromyces races.

At the time the culture work began the subepidermal rusts occurring on wild grasses in America with few exceptions, passed under the name of *Puccinia rubigo-vera,* along with part of the similar leaf rusts of cereals. No criteria had been found for distinguishing them, not even those which had received special

[8] Mycologia 7: 67–69. 1915.

[9] Mycologia 9: 309–312. 1917.

names, and every effort was consequently put forth to make headway into this obscure maze of forms. The first success was in 1902 with a form on *Elymus virginicus* and aecia on Impatiens, which became *Puccinia Impatientis* (Schw.) Arth. The work opened up slowly. In 1903 a false move was made in connection with the rust on Bromus, but the year following this rust was shown to have aecia on *Clematis virginiana*.[10]

In 1907 *Puccinia Agropyri* E. & E., as it occurred in Colorado on Agropyron, was found to go to *Clematis ligusticifolia*, a connection that had been demonstrated by Dietel with European hosts fifteen years before. The following year *Puccinia cinerea* Arth. on Puccinellia was grown on *Ranunculus Cymbalaria*, a rust from *Koeleria cristata* on Mahonia, from Bromus on Thalictrum, from Agropyron on Aquilegia, the last three being described as new species. In 1915 aecia on Hydrophyllum from Utah were made to grow on Agropyron and Elymus, giving rise to uredinia and telia similar to those from the Ranunculaceous aecia, but believed to constitute a distinct species. In 1916 another rust on *Koeleria cristata* was grown on Laciniaria under the name *P. Liatridis* (Ell. & And.) Bethel. Repeated attempts were made to find the aecial host of the common leaf rust of wheat, *P. triticina* Erikss., but without success, although there were many indications that pointed to a Ranunculaceous host, and especially to Clematis or Anemone. It was thought that a favorable trial on *Clematis Flammula* would give a measure of success. At any rate it was believed to be one of the numerous races of the subepidermal leaf-rust of grasses, *P. Agropyri*, with Ranunculaceous hosts for its aecia.[11]

The series were discontinued before the study of the subepidermal forms was completed, but ten of them had been connected with their aecia. The conviction had been growing for some time that some of these ten names represented races of *Puccinia Agropyri*, rather than independent species, as was stated in discussing the cultures of 1912. When the manuscript was pre-

[10] For a full account and explanation of the mistake of 1903 in supposedly connecting aecia on Dirca with the Bromus rust see Journal of Mycology **11**: 62–63. 1905.

[11] Mycologia **9**: 276. 1917.

pared for the North American Flora *P. tomipara, P. Agropyri, P. cinerea, P. alternans* and *P. obliterata,* as well as *P. triticina,* were placed under the one name of *P. Clematidis* (DC.) Lagerh. It is considered a great advance to bring from the limbo of *P. rubigovera,* six distinguishable species, some of them having a considerable number of recognized races, and thereby making it possible to relegate to obscurity some dozen or more names that had previously been encumbering the literature of the rusts.

In a somewhat similar way the American Carex rusts were in utter confusion at the beginning of the cultures. They were quite generally called *Puccinia Caricis* or *P. caricina,* no cultures with American material having been made, and diagnostic characters not having been well worked out. Altogether ten species were grown during the culture period to show their full life cycle, and in several of them a number of races was found, including the one-celled *Uromyces perigynius.* Of course, being able to separate these ten species made it possible to decide upon the identity of other species, which were not actually grown.

A view generally held when the culture work began was that the hosts of an autoecious species, or of each of the two parts of a heteroecious species, would be found to be closely related, often, indeed, to be but a single species, or genus, and certainly always within a single family. Consequently it was felt that when a grass or sedge rust was successfully cultured, the problem about hosts for that species was practically solved. This complacent opinion was quite upset in the case of *Puccinia subnitens* Diet. on *Distichlis spicata,* which in 1902 was first grown upon *Chenopodium album.* In 1904 Rev. J. M. Bates of Nebraska, who had made the field observations and suggestions for this combination, wrote that he had been continuing his observations of this species and believed that it had aecia also on hosts belonging to two other families, which seemed to the writer at the time as most incredible. Tests, however, showed it would flourish on species of Cleome, Lepidium, Sophia and Erysimum, as well as on Chenopodium, compelling the admission that it would grow "with equal vigor upon species belonging to three families of plants," at the time being a "remarkable fact not known for any

other species of rust." Additional genera in the same families were added from time to time for aecial hosts, until in the cultures of 1916 the species was grown on Abronia and Polygonum, thus adding two more families. Mr. E. Bethel, of Denver, Colorado, who made the field observations and suggestions for the later additions, has continued the list since the culture series stopped and brought the number up to 76 species, belonging to 19 families,[12] a truly astonishing showing, and all the more so as no clearly defined races have so far been detected. The only other species of rust with such a remarkably extended series of aecial hosts at all approaching *P. subnitens* Diet., is that of *P. Isiacae* (Thüm.) Wint. from the dry trans-Caspian region of western Asia, as reported by Tranzschel.[13] This species with telia on *Phragmites communis* has aecia on 19 species of hosts belonging to 9 families, the aecial families being the same as for *P. subnitens.*

In still another way the conception of species was modified when in 1905 teliospores from *Ruellia ciliosa* were grown on the same host and also on *R. strepens*. The latter host, with loose, watery tissues, gave rise to aecia fully ten per cent. larger in every way than did the former host with its firm, woody tissues, thus showing that the forms recognized by the Sydows under *Puccinia lateripes* B. & Rav. and *P. Ruelliae* (B. & Br.) Lagerh.[14] represent only a host influence upon one and the same species, this influence being traced not only in the aecia, but also in the other spore-forms.

Thus it will be seen that while the main work of the cultures was effective in completing the life cycles for many species, and in some cases extending and defining the range of hosts, it was at the same time most profoundly modifying the current conception of species among the rusts. Instead of a rigid ideal of a few invariable characters and a limited range of nearly related hosts to be determined by cultures, we have substituted a complex of somewhat variable morphological characters as the basis,

[12] Bethel, Phytopathology 9: 193. 1919.

[13] Beiträge zur Biologie der Uredineen. Trav. Mus. Bot. Acad. Sci. St. Petersb. 3: 40. 1906; 7: 14. 1909.

[14] Sydow, Monographia Uredinearum 1: 235. 1902.

with a more or less extended range of hosts in part determined by cultures and in part by microscopical similarities in the fungus. A species at the beginning of the work was conceived as a simple and direct succession of individuals of the same appearance, capable of being demonstrated by cultures, but at the close had become a bundle of somewhat mobile characters, often comprising many strains varying physiologically and sometimes morphologically, and to a more or less extent not interchangeable by cultures.

In some other ways than already mentioned the accepted notions regarding rusts were modified. It was found that teliospores among the grass forms were not all necessarily resting spores, and that the non-resting forms presented special problems, whose solution was not far advanced when the work came to a close. Assistance with field observations and material permitted successful cultures to be made in May, 1911, with the aeciospores from Arabis sown on Trisetum. The Arabis aecia arise from systemic mycelium extending throughout the stem and leaves of the plant. A month later teliospores resulting from this culture, now having become mature, were found to be capable of germination and were sown on seedling rosettes of Arabis. The results of this sowing first definitely showed when the axis of the Arabis began to elongate as growth started the following spring. A culture was similarly carried out in 1903 with *Puccinia Eatoniae*, using the aecia on *Ranunculus abortivus*, also a form with diffused mycelium, but a reciprocal culture was not made. These two species of rusts, having a systemic form of aecia, were the only ones of the kind which were brought under culture. They belong to an interesting class physiologically, with systemic aecia, and with teliospores capable of germination upon maturity, which possibly do not retain their viability through the winter, or only to an impaired degree.

The culture work began with the too prevalent idea that all rusts could be expected to conform in general to the well known *Puccinia graminis*. It closed with the conviction that the rusts are far too diversified in their morphology, their numerous characters, their physiological adaptations, and their range of hosts.

to be represented by *Puccinia graminis* in more than one out of numerous aspects. In this resumé of cultures only a few of the more prominent developments that should help to modify the too rigid and restricted ideas of rust species as commonly held have been brought forward. Yet enough has been said possibly to indicate the value of what has been accomplished and the need of more extended work along similar lines.

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SOME NEW HAMPSHIRE FUNGI*

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The state of New Hampshire, and in fact most of New England, has been an important collecting ground for considerably more than a half century. Notwithstanding this fact the botanical literature of the region contains only a meager amount of information dealing with its cryptogamic flora. For the state of New Hampshire the writer is aware of but a single paper treating to any extent the fungous flora of the state. This was an eighteen page article by the late Dr. W. G. Farlow, appearing in volume 3 of Appalachia, published in 1884. Here are listed a total of 107 species distributed through 63 genera, representing collections made in the vicinity of Shelburne, Mt. Washington, etc., in 1882 and 1883. Of this list, there are 13 species of Myxomycetes, 2 of Phycomycetes, 33 of Ascomycetes, 16 of Fungi Imperfecti, 6 of Smuts, 20 of Rusts, and 17 of Hymenomycetes.

Aside from this paper the literature contains only incidental reference to fungi collected in or described from the state, although abundant material probably exists in a number of different herbaria. Dr. Farlow, himself, had a summer home at Chocorua, and undoubtedly collected a wealth of material in that locality. Many other botanists have also visited the White Mountain region, and if all this material could be brought together a fairly complete list of the fungi could probably be made up.

In 1918 the writer spent about twenty weeks, from April to September, in New Hampshire, as an employee of the Bureau of Plant Industry, Washington, D. C. During this time headquarters were established at North Conway on the edge of the White Mountains, and not many miles distant from Dr. Farlow's home at Chocorua. This location gave access to an excellent

* Contribution from the Department of Botany, The Pennsylvania State College, No. 26.

forest region of pine, balsam, spruce, and hemlock, as well as to hardwood areas of beech, maple, birch, alder, etc. North Conway and Intervale were the chief local collecting centers. A number of trips were made to Crawford Notch in the heart of the White Mountains, and there the forests are mainly hardwoods with scattering balsam and spruce. An extensive "wind throw" of several years age is located in this region and proved to be a rich collecting ground. One trip was made to Lisbon, another to Bethlehem, and a three day excursion to the summit of Mt. Washington by way of Tuckerman Ravine and returning to Crawford Notch. Advantage was taken of every opportunity for picking up at all times any fungi observed. But only in special groups was the attempt made to collect the same species from different localities or different substrata. In fact, because of other duties, no systematic collecting was done except what might be indulged in at odd times, on holidays, Sundays, etc. Consequently, the species here listed are for the most part the ones that the ordinary collector would casually notice because of their size, coloration, or other conspicuous characteristic. Nevertheless, the number of collections made was sufficient to furnish the appended list of 195 species of fungi, every one of which is represented in the writer's herbarium by one or more collections. These species are here listed under about 77 different genera. It is a curious fact, that in this list scarcely more than a dozen species duplicate collections reported by Dr. Farlow. This is mostly explained by the fact that the species he reported belong largely to the lower groups of fungi, while the writer has collected more among the higher Basidiomycetes. A number of duplicates from these collections have been furnished the Herbarium of the United States Department of Agriculture, the Missouri Botanical Garden, the Herbarium of Dr. J. S. Weir, of Dr. H. H. York, then located at Brown University, Providence, R. I., and of the Department of Botany of the Pennsylvania State College. For this reason the writer's herbarium numbers are always cited in the list, that they may the more definitely identify duplicate collections in other herbaria.

Unless otherwise noted, the collections were made by the

writer, or in company with Dr. H. H. York, to whom the writer is much indebted for assistance. Various other individuals also contributed collections and such are credited in the list. Special thanks are due to those mycologists mentioned for determinations of various collections, as they have thereby added to the completeness and accuracy of the list.

In closing this introduction I cannot fail to mention one of the unsolved problems encountered in the spruce forests of this region. Many individuals of the red spruce (*Picea rubens*) are here attacked by a heart-wood decaying organism producing a "carbonizing" type of decay somewhat similar to that produced in structural timbers by *Trametes carnea.* The attacked heartwood becomes reddish-brown and shrinks and cracks both longitudinally and transversely. In the final stages of decay the wood crumbles to a fine dry powder when rubbed between the thumb and finger. The fate of such trees is sooner or later to become windthrown, breaking off usually within six feet of the ground, indicating that the fungus is especially active in this region of the trunk. Although this disease was recognized early in the season and a constant lookout kept for sporophores, none were found that would in any way indicate the species responsible for the damage caused. The trees are from 5 to 15 inches in diameter, breast high, at the time they are wind thrown. That the causal organism is a member of the Polyporaceae there is little room for doubt, but its generic and specific identity remain to be determined.

FUNGI IMPERFECTI

1. ORDER SPHAEROPSIDALES

1. *Leptothyrium perichymeni* (Desm.) Sacc. On leaves of Lonicera sp. North Conway. No. 5266. Determined by Mrs. F. W. Patterson.
2. *Septoria acerina* Peck. On leaves of *Acer pennsylvanica.* North Conway and Willey Station. Nos. 5695 and 5696, respectively. Determined by Dr. J. J. Davis.
3. *Septoria rubi* West. On leaves of *Rubus villosus.* North Conway. No. 5697.
4. *Septoria saccharina* E. & Ev. On leaves of *Acer saccharum.* Crawford Notch. No. 5690. Determined by Dr. J. J. Davis.

ASCOMYCETES

1. ORDER PERISPORIALES

5. *Microsphaera grossulariae* (Wal.) Lév. On leaves of *Ribes prostratum*. White Horse Ledge (North Conway), No. 5220; Jackson, No. 5221.

2. ORDER HYPOCREALES

6. *Cordyceps militaris* (L.) Link. On larva. Crawford Notch, No. 4983. Distribution recorded by Seaver[1] as "Massachusetts to North Dakota and Virginia."

[1] North American Flora 3: 49. 1910.

7. *Hypomyces hyalinus* (Schw.) Tul. On *Amanita rubescens*. Willey Station, No. 4969; North Conway, No. 5139.
8. *Hypomyces lactifluorum* (Schw.) Tul. On *Lactarius*. North Conway, No. 4754; Intervale, No. 5142.
9. *Nectria cinnabarina* (Tode) Fr. On dead *Acer saccharum*. North Conway, No. 4612; on dead stems of *Ribes prostratum*, No. 4862.
10. *Nectria cucurbitula* Sacc. On bark of fallen *Abies balsamea*. Crawford Notch, No. 4946. Determined by Dr. F. J. Seaver.
11. *Scoleconectria scolecospora* (Bref.) Seaver. On dead branches of *Pinus strobus*. Lisbon, No. 4700. Distribution recorded by Seaver[2] as "New Jersey to Maryland and California." This is the fungus most often associated with the white pine blister-rust in that region.

[2] Loc. cit.

3. ORDER SPHAERIALES

12. *Hypoxylon coccineum* Bull. On bark of *Fagus*. Crawford Notch, No. 4552. Collected by H. H. York and L. E. Newman.
13. *Hypoxylon cohaerens* (Pers.) Fr. On dead *Fagus*. North Conway, No. 5066.

4. ORDER PHACIDIALES

14. *Coccophacidium pini* (A. & S.) Karst. On dead limbs of *Pinus strobus*. North Conway, No. 5044.

5. ORDER PEZIZALES

15. *Dasyscypha agassizi* (B. & C.) Sacc. On fallen *Abies balsamea*. Crawford Notch, No. 4841; base of Mt. Washington, No. 4861. Determined by Dr. F. J. Seaver. Not an uncommon plant and usually making a profuse growth on the dead bark.
16. *Dermatea prunastri* (Pers.) Fr. On dead *Prunus* sp. North Conway, No. 5064. Collected by A. S. Rhoads.
17. *Humaria aggregata* (B. & Br.) Cooke. On the ground among pine needles. North Conway, No. 5063. Determined by Dr. F. J. Seaver who writes in part as follows: "I have seen only one other specimen of this species and that a very small one from Indiana."
18. *Tympanis pinastri* Tul. On fallen trunk of *Abies balsamea*. Crawford Notch Bridle Path to Mt. Washington, No. 5037. The determination was made by Dr. Seaver.

6. ORDER HELVELLALES

19. *Helvella infula* Schaeff. On the ground in moist coniferous woods. North Conway, No. 4932. Determined by Dr. Seaver. The specimens have much the appearance of a small *Gyromitra.*
20. *Leotia lubrica* (Scop.) Pers. In moist humus. North Conway, No. 5080. Rather common.
21. *Microglossum rufum* (Schw.) Underw. On rotten mossy logs. North Conway, No. 5120.
22. *Spathularia velutipes* Cooke & Farlow. On the ground in woods. Willey Station, No. 5083.
23. *Vibrissea truncorum* A. & S. On submerged wood in cold mountain stream. Tuckerman Ravine, No. 4979.

BASIDIOMYCETES

HEMI-BASIDIOMYCETES

1. ORDER USTILAGINALES

24. *Urocystis agrogyri* (Preuss.) Schröt. On an undetermined grass. Kearsarge, No. 4870.

2. ORDER UREDINALES

25. *Coleosporium solidaginis* (Schw.) Thüm. Aecia on needles of *Pinus resinosa.* North Conway, Nos. 4901, 4927. First observed June 12, and last collected Aug. 1. Uredinia and telia on species of *Aster, Solidago* and *Euthamia,* North Conway and Crawford Notch, Nos. 5694 and 5693, respectively.
26. *Cronartium comptoniae* Arth. On *Comptonia asplenifolia.* North Conway, No. 4616; on *Pinus rigida,* North Conway, No. 5126.
27. *Cronartium ribicola* Fischer. Collections are preserved as follows: On *Ribes aureum,* North Conway and Bath, Nos. 4911 and 4596 respectively, the latter collection by H. H. York; on *R. cynosbati,* Lisbon, Bartlett and Jackson, Nos. 4587, 5222 and 4617 respectively; on *R. lacustre,* Crawford Notch, Nos. 4588 and 4594; on *R. nigrum,* Bethlehem and North Conway, Nos. 4619 and 4598 respectively; on *R. oxyacanthoides,* Crawford Notch, No. 4590; on *R. prostratum,* North Conway and slope of Moat Mt. at about 2600 ft. elevation, Nos. 4602 and 4640 respectively, the latter collection by P. R. Gast; on *R. triste,* Crawford Notch, Nos. 4589 and 4600; on *R. vulgare,* North Conway, No. 4601: also observed, but no collections preserved, on *R, grossularia,* at North Conway. The aecial stage on white pine is widely distributed through this part of the state. Numerous collections were made in the region of North Conway, South Conway, Intervale, and Lisbon.
28. *Gymnosporangium clavariaeforme* (Jacq.) DC. On *Juniperus communis* var. *depressa.* North Conway, No. 5001.
29. *Gymnosporangium cornutum* (Pers.) Arth. On leaves of *Sorbus* (*americana*?). Intervale, No. 5689. Determined by F. D. Kern.
30. *Kuhneola uredinis* (Link) Arth. On leaves of *Rubus villosus.* Tuckerman Ravine, No. 4889.

31. *Melampsora medusae* Thüm. On leaves of *Populus tremuloides*. North Conway, No. 4657. Collected by A. S. Rhoads.

32. *Melampsorella elatina* (A. & S.) Arth. On *Abies balsamea*, forming witches brooms. North Conway, No. 4890.

33. *Melampsoridium betulae* (Schum.) Arth. On *Betula populifolia*. North Conway, No. 4670. Collected by A. S. Rhoads.

34. *Puccinia clematidis* (DC.) Lagerh. Aecia on leaves of *Clematis* sp. Crawford Notch, No. 4909.

35. *Puccinia fraseri* Arth. On leaves of *Hieracium* sp. North Conway, No. 5692. Determined by Prof. C. R. Orton.

36. *Puccinia graminis* Pers. Pycnia and aecia on leaves of *Berberis vulgaris*. Intervale, No. 4649.

37. *Puccinia grossulariae* (Schum.) Lagerh. Aecia on *Ribes prostratum* and *R. cynosbati*; at Crawford Notch and Jackson respectively; Nos. 4585 and 4614 respectively.

38. *Puccinia obscura* Schroet. On leaves of *Luzula*. Jackson, No. 5687. Collected by H. H. York. Determined by C. R. Orton.

39. *Puccinia pedatata* (Schw.) Arth. Aecia on leaves of *Viola saggitata*?. North Conway, No. 4908.

40. *Puccinia physostegiae* (Peck) Kuntze. Aecia on leaves of *Physostegia virginiana*. North Conway, No. 4913.

41. *Puccinia taraxaci* Plowr. On leaves of *Taraxacum officinale*. No. 5688. Collected by H. H. York.

42. *Uredinopsis mirabilis* (Peck) Magnus. On leaves of *Abies balsamea*. Franconia, No. 4980; on leaves of *Dryopteris, Franconia*, No. 5288.

43. *Uromyces caladii* (Schw.) Farlow. Aecia on *Arisaema triphyllum*. North Conway, No. 4910.

44. *Uromyces houstoniata* (Schroet.) Sheldon. Aecia on *Houstonia coerulea*. North Conway, No. 4616.

EU-BASIDIOMYCETES

1. Family Tremellaceae

45. *Exidia glandulosa* (Bull.) Fr. On dead *Fagus*. North Conway, No. 5116.

46. *Sebacina calcea* (Pers.) Bres. On fallen *Pinus rigida*. Intervale, No. 5108. The fungus was determined by Dr. E. A. Burt.

47. *Tremellodon gelatinosum* (Scop.) Fr. On rotten hemlock stump. North Conway (Hales Location), No. 5158.

2. Family Dacryomycetaceae

48. *Calocera cornea* Fr. On log of *Acer*. Crawford Notch, No. 4746.

49. *Dacryomyces hyalinus* Quel. On hemlock(?) log. Intervale, No. 5147. Determined by Mr. C. G. Lloyd.

3. Family Thelephoraceae

50. *Aleurodiscus acerinus* (Pers.) v. Hohn. & Litsch. On bark of living *Fraxinus americanus*. North Conway, No. 5104.

51. *Aleurodiscus amorphus* (Pers.) Rab. On dead limbs of *Abies balsamea*. Crawford Notch Bridle Path to Mt. Washington, No. 4840.
52. *Corticium albulum* Atk. & Burt. On dead *Prunus*. North Conway, No. 5111.
53. *Corticium galactinum* (Fr.) Burt. All collections at North Conway. On coniferous logs, No. 4555; on hemlock log, No. 5131; on log of *Acer*, No. 4584; on log of *Betula populifolia*, No. 4945. No. 4555 and 4584 were determined by Dr. E. A. Burt.
54. *Corticium lactum* Karst. On dead *Alnus*. Crawford Notch (Mt. Webster), No. 5079.
55. *Corticium subgiganteum* Berk. On dead *Acer* branches. North Conway (Hales Location), No. 5062. Determined by Dr. E. A. Burt.
56. *Cyphella fasciculata* (Schw.) B. & C. On dead *Alnus*. North Conway, No. 5052.
57. *Hymenochaete abnormis* Peck. On the exposoed heart-wood on the end of a log of *Picea rubens*. Crawford Notch, No. 4948. The determination was made by Dr. E. A. Burt, who, however, prefers to class the fungus in the genus *Stereum* rather than in *Hymenochaete*. It has considerable resemblance to *H. rubiginosum* (Dicks.) Lév. Spores cylindric when mature, hyaline, $7-12 \times 3-4\,\mu$, sometimes somewhat shorter when on basidia.
58. *Hymenochaete corrugata* (Fr.) Lév. On dead wood, probably of *Acer*. North Conway, No. 5053.
59. *Hymenochaete tabacina* (Sow.) Lév. All collections in the vicinity of North Conway. On wood of *Acer*, Nos. 4734 and 4551; on wood of *Acer rubrum*, No. 5036; on fallen hemlock, No. 5112. A coniferous host for this species is not often found.
60. *Peniophora affinis* Burt. On dead *Alnus incana*. North Conway, No. 5106.
61. *Peniophora allescheri* Bres. On dead *Populus*. North Conway, No. 4564.
62. *Peniophora carnosa* Burt. On rotten *Acer* log. North Conway, No. 4732; on fallen *Pinus rigida*, Intervale, No. 5039.
63. *Peniophora cinerea* (Fr.) Cooke. On dead *Ulmus americana*. No. 4858.
64. *Stereum ambiguum* Peck. On coniferous fence timber. North Conway, No. 4553.
65. *Stereum hirsutum* Fr. On dead *Alnus*. North Conway, No. 5009.
66. *Stereum lilacino-fuscum* (B. & C.) Burt. On dead *Acer* twigs. Nos. 5032, 5161.
67. *Stereum rameale* Schw. On fallen *Acer rubrum*. North Conway, No. 4956; on *Fagus americana*, No. 5020.
68. *Stereum rufum* Pers. On dead *Populus* twigs. North Conway, No. 4931.
69. *Stereum sanguinolentum* A. & S. On fallen *Abies balsamea*. Tuckerman Ravine, No. 4949; on *Tsuga canadensis*, North Conway, No. 4963.
70. *Stereum sulcatum* Burt. On log of *Tsuga canadensis*. North Conway, No. 5033. Determined by Dr. E. A. Burt.
71. *Stereum tuberculosum* Fr. On fallen *Acer saccharum*. Crawford Notch, No. 4582; on coniferous log, North Conway, No. 5074; on dead *Betula*, North Conway, No. 5110.

72. *Thelephora palmata* Fr. On the ground in woods. North Conway, No. 4978. With a decidedly foetid odor in fresh plants.

73. *Thelephora terrestris* (Ehrh.) Fr. On the ground and growing over mosses, twigs, etc. North Conway, No. 4873; on rotten stump of *Pinus resinosa*, No. 4958. Both collections were made by Dr. H. H. York.

74. *Tulasnella fusco-violacea* Bres. On bark of *Abies balsamea*. Crawford Notch, No. 4883. Determined by Dr. E. A. Burt. There occurs rather abundantly in this region a peculiar fungus growing exclusively on the bark of living trees of *Pinus strobus*, in which it forms orbicular patches 1 to 2.5 cm. broad. It is entirely resupinate, or at least practically so, and of a light brown color. The surface is rough with a matter, strigose pubescence. No hymenium can be found. In general appearance the fungus has the appearance that one would expect of a resupinate species of *Stereum*. However, Dr. Burt suggests that it may be a species of *Septobasidium*. Mycologists who have opportunity to collect in this region through a longer period of time than have I can render a distinct service by observing and collecting this peculiar fungus in the endeavor to obtain it in fruiting conditions. It can be found on the uninjured bark of trees 20 to 50 years old, and only where they grow in dense stands.

4. Family Clavariaceae

75. *Clavaria fusiformis* Sow. Among moss in forest trail. North Conway, No. 5060. Collected by Dr. H. H. York.

76. *Clavaria krombholtzii* Fr. On the ground in woods. North Conway, No. 5172.

5. Family Hydnaceae

77. *Asterodon setigera* Peck. On rotten hemlock log. North Conway, No. 5059.

78. *Hydnum coralloides* (Scop.) Fr. On end of oak log. North Conway, No. 5148.

79. *Hydnum ochraceum* Pers. On log of *Acer*. North Conway, No. 4736.

80. *Phlebia strigoso-zonata* Schw. On dead *Populus*. North Conway, No. 5133.

81. *Radulum casearium* Morgan. On log of *Populus*. North Conway, Nos. 4637, 5132.

6. Family Agaricaceae

82. *Amanita flavoconia* Atk. In rich humus in woods. North Conway, Nos. 4569, 4729 and 4738.

83. *Amanita morrisii* Peck. On the ground in damp woods. North Conway, No. 4737.

84. *Amanita muscaria* (L.) Fr. On the ground under aspens. Willey Station, No. 4663.

85. *Amanita rubescens* Fr. On the ground in moist woods. North Conway, No. 4735.

86. *Armillaria mellea* Vahl. On roots of a dead *Prunus serotinus.* North Conway, No. 5095.
87. *Cantharellus cibarius* Fr. On the ground in woods. North Conway, No. 4748.
88. *Cantharellus floccosus* Schw. On the ground in woods. North Conway, Nos. 5065 and 5135.
89. *Cantharellus umbonatus* Fr. Among Polytrichum moss under pines. North Conway, Nos. 4749 and 4977.
90. *Clitocybe clavipes* Pers. On the ground under pines. North Conway, No. 4930.
91. *Clitocybe infundibuliformis* Bull. Among Polytrichum moss under alders. No. 4658.
92. *Clitocybe virens* (Scop.) Fr. On the ground under aspens. Willey Station, No. 4751.
93. *Collybia acervata* Fr. On rotten wood. Crawford Notch (Mt. Webster), No. 4965.
94. *Collybia dryophila* (Bull.) Fr. On the ground under pines. North Conway, No. 4866.
95. *Collybia platyphylla* Fr. Around an old stump. North Conway, No. 4756.
96. *Hypholoma incertum* Peck. On a lawn. North Conway, No. 4856. Collected by Dr. H. H. York.
97. *Lactarius deceptivus* Peck. On the ground in woods. North Conway, Nos. 4825 and 4851. The latter collection by Dr. A. S. Rhoads.
98. *Lactarius hygrophoroides* Peck. On the ground in woods. North Conway, No. 4757.
99. *Lentinus lepideus* Fr. On railway ties, North Conway, No. 4554; on pine stump, North Conway, No. 5105. A very common species.
100. *Lentinus ursinus* Fr. On rotten log. North Conway, No. 4871.
101. *Lepiota granulosa* (Batsch) Fr. On the ground under aspens. Willey Station, No. 4758.
102. *Lepiota procera* (Scop.) Fr. On the ground in woods. North Conway, No. 4872.
103. *Marasmius androsaceus* (L.) Fr. On needles, twigs, etc., on the ground. North Conway, No. 5134.
104. *Marasmius archyropus* Fr. On the ground in woods. Crawford Notch, No. 5090.
105. *Marasmius multifolius* Peck. On the ground under aspens. Willey Station, No. 5087.
106. *Marasmius oreades* (L.) Fr. By grassy roadside. North Conway, No. 5081.
107. *Marasmius rotula* (Scop.) Fr. On beech log. Crawford Notch, No. 5141.
108. *Marasmius subnudus* (Ellis) Peck. On the ground and on wood. North Conway, No. 5159.
109. *Mycena leaiana* Berk. On log of *Fagus.* North Conway, No. 4563.
110. *Panaeolus solidipes* Peck. On manure heap. North Conway, No. 4761.
111. *Panus rudis* Fr. On log of *Fagus.* North Conway, No. 5127.
112. *Paxillus atrotomentosus* (Batsch) Fr. On the ground by a pine stump. North Conway, Nos. 4750 and 4753.

113. *Paxillus involutus* Fr. On the ground in woods. North Conway, No. 4752.
114. *Pholiota marginella* Peck. On rotten mossy log. North Conway, No. 4762.
115. *Pholiota mycenoides* Fr. In wet, marshy ground among scattered *Sphagnum*. North Conway, No. 4943.
116. *Pleurotus ostreatus* (Jacq.) Fr. On fallen beech, Crawford Notch, No. 4855; on dead wood, Intervale, No. 5000.
117. *Pluteus cervinus* (Schaeff.) Fr. In old roadway. North Conway, No. 5153.
118. *Pluteus leoninus* (Schaeff.) Fr. On a rotten log. North Conway, No. 4929.
119. *Russula flavida* Frost. On the ground in woods. Intervale, No. 4667.
120. *Russula mariae* Peck. On the ground in a woods road. No. 5150.
121. *Tricholoma laterarium* Fr. On leaf mold in forest. North Conway, No. 5050.
122. *Trogia crispa* Fr. On dead *Betula populifolia*. North Conway, No. 4982; collected by Dr. A. S. Rhoads; on dead beech limbs, Willey Station, No. 5051.

7. Family Boletaceae

123. *Boletinus pictus* Peck. On the ground in woods. North Conway, No. 5136.
124. *Boletus communis* (Bull.) Fr. On the ground in woods. North Conway, No. 4972.
125. *Boletus cyanescens* (Bull.) Fr. On the ground by roadside. Crawford Notch, No. 4744.
126. *Boletus edulis* (Bull.) Fr. On the ground in woods. North Conway, No. 4960.
127. *Boletus felleus* (Bull.) Fr. On the ground in woods. North Conway, No. 4755.
128. *Boletus ferruginatus* (Batsch) Fr. On the ground in woods. North Conway, No. 4826.
129. *Boletus fumosipes* Peck. On the ground in woods. Willey Station, No. 5160.
130. *Boletus granulatus* (Bull.) Fr. On the ground under trees. North Conway, No. 5107.
131. *Boletus scaber* (Bull.) Fr. On the ground in woods. Intervale, No. 4976.
132. *Boletus subaureus* Peck. On the ground in woods, especially in trails and grassy places. North Conway, No. 4985. Common.
133. *Boletus subglabripes* Peck. On the ground in woods. North Conway, No. 4937.
134. *Boletus subtomentosus* (L.) Fr. On the ground under pines. North Conway, No. 5156.

8. Family Polyporaceae

135. *Daedalea unicolor* (Bull.) Fr. On dead *Acer* and also on *Fagus*. North Conway, Nos. 4842 and 4859.

136. *Favolus canadensis* Klotzsch. On beech limbs. North Conway, No. 4876.
137. *Fomes applanatus* (Pers.) Wallr. On *Acer* stump. North Conway, No. 4694.
138. *Fomes connatus* (Weinm.) Gill. On *Acer saccharinum*. North Conway, No. 4743; on *Acer rubrum*, No. 4986.
139. *Fomes conchatus* (Pers.) Fr. On dead *Acer rubrum*. North Conway, No. 4733; on dead *Acer rubrum*, Intervale, No. 4849; on living *Fraxinus americana*, North Conway. No. 4968.
140. *Fomes fomentarius* (L.) Gill. On *Betula lutea*. North Conway, No. 4724; Intervale, No. 4725.
141. *Fomes igniarius* Fr. On fallen *Populus*. North Conway, No. 4562; on fallen *Populus deltoides*, Crawford Notch, No. 4648; on *Betula lutea*, Jackson and Crawford Notch, Nos. 4727 and 4940; on *Betula populifolia*, Crawford Notch, No. 4951; on *Betula lutea*, Tuckerman Ravine, No. 4966; on dead *Betula alba*, Willey Station, No. 5085.
142. *Fomes pini* (Brot.) Lloyd. On hemlock log. North Conway, No. 4846.
143. *Fomes pinicola* (Sw.) Cooke. On *Betula lutea*. North Conway, No. 4695; on *Abies balsamea*, North Conway, No. 4704, collected by Dr. H. H. York; on dead *Prunus*, Crawford Notch, No. 4947.
144. *Fomes roseus* (A. & S.) Cooke. On dead *Tsuga canadensis*. North Conway, No. 5004.
145. *Fomes scutellatus* Schw. On dead *Alnus*. North Conway, No. 5089.
146. *Lenzites saepiaria* Fr. On rotten coniferous log. North Conway, No. 4742.
147. *Polyporus abietinus* Fr. On *Tsuga canadensis*. North Conway, No. 5008; on fallen *Abies balsamea*, Crawford Notch, No. 5121.
148. *Polyporus adustus* (Willd.) Fr. On dead *Populus*. North Conway, No. 4739; on fallen beech log, Crawford Notch, No. 4868.
149. *Polyporus anceps* Peck. The following collections at North Conway: On dead limbs of *Pinus resinosa*, No. 4865; on trunk of dead *Pinus resinosa*, No. 4988; on dead standing hemlock, No. 5026.
150. *Polyporus betulinus* (Bull.) Fr. On *Betula alba*. Crawford Notch, No. 4839.
151. *Polyporus biformis* Klotzsch. On beech log. North Conway, No. 4957.
152. *Polyporus brumalis* (Pers.) Fr. On dead deciduous wood. North Conway, No. 5084.
153. *Polyporus chioneus* Fr. The following collections at North Conway: On dead *Populus*, No. 4926; on dead *Prunus serotinus*, No. 4941; on log of *Betula*, No. 5006.
154. *Polyporus cinnabarinus* (Jacq.) Fr. On log of *Acer*. Crawford Notch, No. 4568; on fallen *Acer saccharum*, North Conway, No. 5145, collected by Dr. H. H. York and Mr. L. E. Newman.
155. *Polyporus conchifer* (Schw.) Fr. On dead elm branches. North Conway, No. 4745.
156. *Polyporus dichrous* Fr. On dead *Alnus*. North Conway (Hales Location), No. 4987.
157. *Polyporus elegans* (Bull.) Fr. On dead wood. Crawford Notch, No. 5005.

158. *Polyporus epileucus* Fr. ex Lloyd. On fallen *Acer*. Crawford Notch, No. 5002.

159. *Polyporus guttulatus* Peck. On fallen *Abies balsamea*. On Crawford Notch trail to Mt. Webster, No. 5152.

160. *Polyporus hirsutus* (Wulf.) Fr. On fallen beech. Crawford Notch, No. 4864; also on fallen *Populus*, No. 4898.

161. *Polyporus montagnei* Fr. On the ground, probably attached to buried wood. North Conway, No. 4999.

162. *Polyporus pargamenus* Fr. On *Acer rubrum*. Intervale, No. 4650; on fallen *Populus*, Kearsarge Mt. and Crawford Notch, Nos. 4707 and 4884, respectively; on dead *Salix*, North Conway, No. 4884, collected by Dr. A. S. Rhoads.

163. *Polyporus perennis* (L.) Fr. On ground under aspens and in forest trails. Willey Station, No. 5055. Of this species larger specimens were collected than had ever before been observed by the writer, some being as much as 11 cm. broad. It is the common, brown, centrally stipitate species of forest trails and roadsides in this region.

164. *Polyporus picipes* Fr. On rotten *Abies balsamea*. Crawford Notch, No. 4934; on log of *Acer*, No. 4952. A coniferous host for this species is extremely uncommon.

165. *Polyporus pubescens* (Schum.) Fr. On dead *Acer saccharum*. Crawford Notch, No. 5113. Observed but once.

166. *Polyporus radiatus* (Sow.) Fr. On stump of *Betula lutea*. North Conway, No. 5078; on dead *Alnus*, No. 5122.

167. *Polyporus schweinitzii* Fr. On roots of pine stumps. North Conway, Nos. 4740 and 5155.

168. *Polyporus semipileatus* Peck. On dead beech limbs. North Conway, No. 4852.

169. *Polyporus semisupinus* B. & C. On dead *Alnus*. North Conway (Hales Location), No. 5093. Found but once.

170. *Polyporus sulphureus* (Bull.) Fr. On old hardwood log. North Conway, No. 4722. Collected by Dr. H. H. York.

171. *Polyporus tsugae* Murrill. On dead hemlock. Intervale, No. 4613, by Mr. J. Corliss; North Conway, No. 4620.

172. *Polyporus tulipiferus* (Schw.) Overh. On dead *Acer pennsylvanica*. Crawford Notch, No. 4583; on dead *Prunus serotinus* and also on dead beech limbs, North Conway, Nos. 4967 and 5130 respectively.

173. *Polyporus ursinus* Lloyd. On log of *Picea rubens*. North Conway, No. 6076. This species was collected in August, 1920, by Mr. Walter H. Snell. It is a rare plant though rather widely distributed in the United States.

174. *Poria attenuata* Peck. On dead hardwood. North Conway, No. 4566; on dead *Acer* limbs, No. 5171.

175. *Poria attenuata* var. *subincarnata* Peck. On dead limbs of *Tsuga canadensis*. North Conway, Nos. 5034 and 5099. This plant is not a variety of *P. attenuata* as has already been pointed out by the writer (Bull. N. Y. State Mus. 205–206; 73–74. 1919.) It is a distinct species but whether or not otherwise named I cannot say at present.

176. *Poria betulina* Murrill. On fallen *Betula populifolia*. Crawford Notch, Nos. 4565 and 5013; on *Betula alba*, No. 5025. This species has been extensively studied by the writer and will be considered more in detail in a paper soon to be published. It is common throughout the northeastern states, but without knowing the host it is difficult to distinguish from resupinate forms of *Fomes igniarius*. The spores were originally described as "ovoid, smooth, fulvous, 4–5 μ long." They are, however, subglobose, smooth, *hyaline*, and measure 5–6 μ in diameter. The species is consequently misplaced in Murrill's genus *Fomitiporella*, in which the brown spores are made a generic character.

177. *Poria ferruginosa* (Schrad.) Fr. On dead limbs of *Acer*. North Conway, No. 4672; on fallen *Prunus serotinus*, Crawford Notch, No. 4971; on dead *Fagus*, Willey Station, No. 5096. Among other brown resupinate species this one is well characterized by the abundant setae, the distinctly oblong or oblong-ellipsoid hyaline spores measuring 4–5 $\times$ 2–2.5 μ, and by being confined to the wood of deciduous trees.

178. *Poria fimbriata* Pers. On rotten wood. North Conway, No. 4607. The species is sometimes known as *Porothelium fimbriatum*.

179. *Poria medulla-panis* Pers. On old limbs of deciduous trees. North Conway, No. 5035.

180. *Poria nigrescens* Bres. On rotten *Betula*. North Conway, No. 4942.

181. *Poria prunicola* Murrill. On dead *Prunus*. Crawford Notch, No. 4580. This is a rather common *Poria* on dead *Prunus*, especially at the higher elevations in the vicinity of Crawford Notch. Its affinities are with *Poria betulina*. Setae are rare, but usually present.

182. *Poria subacida* Peck. On fallen *Acer rubrum*. Intervale, No. 4641; on fallen hemlock, North Conway, Nos. 4827 and 5046; on fallen *Abies balsamea*, Intervale, No. 4974; on dead *Betula*, North Conway, No. 5049; on log of *Pinus Strobus*, North Conway, No. 5097. A common and variable species.

183. *Poria tsugina* Murrill. On log of *Tsuga canadensis*. North Conway and Lisbon, Nos. 4962 and 5091 respectively.

184. *Trametes carnea* Nees. On log of *Picea mariana* and on pine log. North Conway, Nos 4731 and 4933 respectively.

185. *Trametes heteromorpha* Fr. On fallen *Abies balsamea*. Crawford Notch, No. 5045. This species has only recently been recognized in this country (see Overholts, Polyporaceae of the Middle-Western United States, p. 74. 1915). Its occurrence in such widely separated localities as Idaho and New Hampshire argues for a wide distribution.

186. *Trametes malicola* B. & C.? On rotten log of hemlock or red spruce. North Conway, No. 5100. The specimens may belong rather under *Fomes annosus*. More recent studies indicate that the real affinities of this species are with *Fomes annosus* under which it is now included as a weathered form.

187. *Trametes mollis* Sommerf. On fallen *Acer*. Crawford Notch, No. 4608, collected by Dr. H. H. York and Mr. L. E. Newman; on fallen *Fagus* and *Acer*. Crawford Notch, No. 5129.

188. *Trametes peckii* Kalchbr. On log of *Populus grandidentata* Dundee, No. 5047.

189. *Trametes sepium* B. & C. On oak fence posts. North Conway, No. 5123.

190. *Trametes serialis* Fr. On coniferous wood. North Conway, No. 4854; on fallen *Abies balsamea*, Crawford Notch, No. 4925; on hemlock log, Lisbon, No. 5073.

191. *Trametes variiformis* Peck. On hemlock logs. North Conway, Nos. 4571 and 4605; on fallen *Picea rubens*, North Conway, No. 5076.

ADDENDA

192. *Puccinia gnaphaliata* (Schw.) Arth. & Bisby. Aecia on *Gnaphalium* sp. North Conway, No. 5225. Collected by H. H. York. Determined by C. R. Orton, who includes the species in the genus *Allodus* as recently monographed by him. *P. investita* Schw. is given as a synonym.

193. *Pucciniastrum potentillae* Kom. Uredinia on leaves of *Potentilla tridentata*. Tuckerman Ravine, Mt. Washington, No. 5226. Determined by C. R. Orton. This species is not included in the treatment of the genus *Pucciniastrum* as given in the North American Flora. Dr. J. J. Davis records it from Wisconsin on the same host.

194. *Septoria humuli* Westend. On leaves of *Humulus*. Intervale, No. 5219. The spore measurements, 20–30 × 1 μ, agree better with this species than with *S. lupulina* Ellis & Kell.

195. *Septoria ribis* Desm. On leaves of seedling *Ribes prostratum*. North Conway, No. 5227. Spores linear, elongate, curved or straight, 40–60 × 1 μ. No septations are visible in the spores but the fruiting body is surely a pycnidium rather than an acervulus.

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THE FUNGI OF THE WILKES EXPEDITION

William W. Diehl

The U. S. Exploring Expedition under the command of Charles Wilkes, 1838–42, in connection with other work of a scientific character made collections of plants which have been a notable contribution to a floristic knowledge of the lands explored. The fungi collected on this expedition (1) were, however, singularly few, thirty-one in all, eight of which were described as new (2).

In spite of the character of this limited collection and the status of Berkeley and Curtis as eminent mycologists of the period, the eight new species do not seem to have been generally recognized in the literature. Massee (3) in his monograph does not mention Nos. 21 and 23. Cooke (4) in his "Australian Fungi" makes no mention of these Berkeley and Curtis species. Hennings (5) in a compendium of South Sea fungi calls attention to but one of the list, No. 21, as *Thelephora lamellata* B. Guppy (6) listing the fungi of the Solomon Islands similarly cites this species only. Berkeley (7) himself cites only this one of the Wilkes Expedition names in his "Fungi of the Challenger Expedition." None of them occurs in Berkeley's (8) part of the Flora of New Zealand. It is indeed strange that Berkeley and others, except by citation of the Wilkes literature, do not seem to refer in subsequent publications to any other collections of these species either directly or in synonymy.

This lack of reference to these fungi is doubtless due to the fact that the types have been lost to mycologists in that they have probably not been recognized since their original description. The species were published (2) as new less than six months after Curtis studied them, if his study was coincident with his reference in a letter to Professor Edw. Tuckerman dated Dec. 9, 1850.[1] He notes finding some lichens among the fungi of the

[1] Dr. C. L. Shear has kindly permitted the writer to examine a photostat copy of the letters written to Tuckerman from 1847 to 1850.

U. S. Exploring Expedition; he says further: "The fungi are few—30 species only—8 new." Collins (9) describes the unfortunate disposition of various specimens and publications of the Wilkes Expedition. The fungi apparently met a similar experience since less than half can be located. In the early days of the U. S. Department of Agriculture, as revealed by the old handwriting on index cards and by the character of the specimen envelopes, some of these were inserted in what is now the Pathological Collections of the Bureau of Plant Industry, where they have been kept intact though unrecognized as belonging to the Wilkes Collection. A search through the governmental herbaria did not reveal the presence of any others. Those numbers that were located are noted in the appended list by an asterisk. The authenticity of these specimens is definitely established by the fact that each contains a note in the peculiar hand-printing used for labels by M. A. Curtis in which the numbers, names, and localities correspond to those in the original list (1). Furthermore, the notes in the publication (1) stating that there were in the collection but one specimen of No. 13, and but two of No. 31, and the agreement of the figure of No. 31, fig. 8, (1) with the specimen absolutely eliminates any doubt respecting these two instances. According to the instructions of J. K. Paulding (10), then Secretary of the Navy, to Commander Wilkes, "You will require from every person under your command the surrender of all journals . . . as well as all specimens, etc.," it would appear that it was the intention to keep all specimens entirely under governmental care; and doubtless the fungi were in charge of Berkeley and Curtis only during their study. This would explain the apparent absence of any of these types from other herbaria[2] and a consequent lack of reference to them in the literature.

It is thus seen that all the types (possibly *in sensu stricto*) with the exception of No. 20, *Favolus platyporus*, are preserved. It is worthy of note that Berkeley and Curtis (1) considered No. 13, *Polyporus brunneolus*, to be similar to the type, giving it a significant status. The orthography of the list is that of the publication (1).

[2] Through the courtesy of Mr. Arthur W. Hill, Assistant Director of the Royal Botanic Gardens, it has been learned that none of these types is at Kew.

* 1. *Agaricus (Pleuropus) lagotis* Berk. & Curt. Oahu, Sandwich Islands.
2. *Agaricus ignobilis* Berk. Feejee Islands.
* 3. *Agaricus (Flammula) croesus* Berk. & Curt. Waya-ruru Bay, New Zealand.
4. *Agaricus* ——. Mauna Kea, Hawaii, Sandwich Islands.
5. *Cantharellus aurantiacus* Fries. Fort Vancouver, Oregon.
* 6. *Lentinus wilkesii* Berk. & Curt. Feejee Islands.
7. *Schizophyllum commune* Fries. Sandwich Islands.
8. *Lenzites repanda* Fries. Samoan Group, Navigators' Islands.
* 9. *Trametes australis* Fries, var. Mangsi Islands.
10. *Trametes lactea* Berk. Woolongong, New South Wales.
11. *Polyporus perennis* Fries. Island of Madeira.
12. *Polyporus sanguineus* Fries. Brazil; also Feejee and Mangsi Islands.
*13. *Polyporus brunneolus* Berk. Samoan Islands.
*14. *Polyporus flabelliformis* Klotsch. Sandal-wood Bay, Feejee Islands.
15. *Polyporus australis* Fries. Ovolau, Feejee Islands.
16. *Polyporus cinnabarinus* Fries. Feejee Islands, New Zealand, and New South Wales.
*17. *Polyporus vellereus* Berk., var. *poris minoribus*. Puget's Sound, Oregon.
*18. *Polyporus liturarius* Berk. & Curt. Ovolau, Feejee Islands.
19. *Polyporus (imperfectus)*. Samoan Grop, Navigators' Islands.
20. *Favolus platyporus* Berk. & Curt. Feejee Islands.
*21. *Thelephora lamellata* Berk. & Curt. Feejee Islands.
*22. *Thelephora aurantiaca* Pers. var. Samoan Group, Navigators' Islands.
*23. *Thelephora scabra* Berk. & Curt. Ovolau, Feejee Islands.
24. *Stereum lobatum* Fries. Bay of Islands, New Zealand.
25. *Stereum complicatum* Fries. var. Ovolau, Feejee Islands.
26. *Exidia hispidula* Berk. New Zealand, Sandwich, and Mangsi Islands.
27. *Batarrea phalloides* Pers. Oregon.
28. *Lycoperdon pusillum* Batsch. var. Bay of Islands, New Zealand.
29. *Clathrus (Laternea) triscapus* Fr. Relief Bay, Fuegia.
30. *Hypoxylon concentricum* Bolt. Volcano of Maui, Sandwich Islands.
*31. *Hypoxylon pilaeforme* Berk. & Curt. Oahu, Sandwich Islands.

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[3] This is the author's edition; the official edition of Vol. 17 'by the authority of Congress' of which there are copies in the Library of Congress was printed without plates and apparently without an atlas.

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CLITOCYBE SUDORIFICA AS A POISONOUS MUSHROOM

J. W. ROBERTS

On October 15, my wife collected some mushrooms which were growing on the Hall at Washington. I identified them as belonging to the genus *Clitocybe,* probably *Clitocybe dealbata.* In order to determine whether or not they were edible, I took a few nibbles just before dinner on the evening of October 15. No ill results were noticed. The next morning before breakfast, I ate one entire cap without any feeling of discomfort resulting. That night at dinner my wife and myself ate about eight or ten each. Those eaten at this time were creamed. We thought we noticed no ill effects but I remember that I perspired more freely than usual and remarked to my wife that the lights in a nearby apartment house had a peculiar appearance. However at the time I attributed the former to the fact that the heat was turned on in our apartment and the latter to peculiar atmospheric conditions. Since the flavor of these mushrooms was very pleasant more of them were collected on the morning of October 18 and served with meat that evening at dinner. My wife ate something like eight of them and I ate probably twice that number.

At about 6:45, or one half hour after dinner, I began to feel very warm and was perspiring very freely. At about 7:00 o'clock my eyes began to give out and I was compelled to stop reading. At 7:30 I looked at my watch and had some difficulty in telling the time. At 8:20 I was so warm and perspiring so freely that I opened the outside door of the apartment and put on lighter clothing. Shortly afterward my wife came in from another room and said she was not feeling well. I mentioned that I could read no longer for despite my glasses which magnify slightly, I was unable to see clearly. She at once said that she could not see distinctly. To both of us all objects appeared blurred. Lights appeared as sun-bursts of remarkable beauty.

This derangement of sight was due to the contraction of the pupils.

Realizing that the trouble was due to mushrooms, a physician was summoned. He arrived shortly before 9:30. Before his arrival we had taken emetics to good effect. He gave additional emetics and bits of mushrooms were among the things brought up.

I was also, beginning at about nine o'clock, affected with diarrhoea. At about the same time my muscles began twitching and by nine-thirty I had very little control of my legs and arms. I was, for instance, unable to pick up a glass of water with one hand. There was also a very pronounced flow of saliva and my clothing were soaked with perspiration. There was a scantiness of urine, in fact none was voided between 6:00 o'clock that evening and 9:00 o'clock the next morning, at which time less than two ounces was given off. My pulse was rapid, being about 90, whereas it is usually around 70. Respiration was, I believe, about normal, at least I do not recall having any difficulty in breathing, or being troubled with shortness of breath.

After the physician was satisfied that the stomach was empty, purgatives were given and atropine was administered subcutaneously. We were then ordered to bed under heavy covering and with hot water bottles at our feet. Within a short time, I should say half an hour, I had recovered control of my muscles and was experiencing a mental exhilaration. I enjoyed the peculiar appearance of the lights and glistening objects and told the doctor and the nurse that I felt better than I usually did when well.

At 2:00 o'clock the next morning I went to sleep, awakening at 6:00 and again at 9:00. At 9:00 I arose and looked over the morning paper with eyesight apparently normal. My wife complained of pain at the top of her head but I felt no pain anywhere. In fact, save for my wife's headache neither of us had felt any pain throughout the whole experience. Both of us were in possession of our mental faculties throughout.

During the day following I was as usual save for scantiness of urine, scantiness of saliva and lack of sense of taste. Pulse, perspiration, sight, etc., were apparently normal.

By the next afternoon, October 20, the flow of urine became normal or nearly so, but the scantiness of saliva persisted a day longer.

My sense of taste, I have not yet fully regained at this date, October 22, the fourth day after the mushrooms were eaten. There was no after effect of stupor or coma with slowing up of the heart beat.

On October 20, specimens of the mushroom were submitted to Miss Vera K. Charles, who very kindly identified it for me. Miss Charles also cited me to Murrill's note on this species as follows:

Clitocybe sudorifica Peck, Bull. N. Y. State Mus. 157: 67. 1912.

First described as a variety of *C. dealbata* from specimens collected in grassy ground at Saratoga, New York, by F. G. Howland. It has been collected in two or three other localities in Albany and Ontario counties. Mr. Howland, Dr. Peck, and Dr. W. W. Ford all agreed that this mushroom was decidely sudorific and unwholesome, differing decidedly in this respect from the reputation enjoyed by *C. dealbata*. I have examined the types, however, and can see no morphologic difference between the two plants. They both grow gregariously in exposed grassy places and the best observer could not tell them apart.—Murrill, W. A. In Mycologia 7: 274–275. 1915.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

OBSERVATIONS ON THE INFECTION OF CRATAEGUS BY GYMNOSPORANGIUM[1]

J. F. Adams

An interesting growth of the red cedar (*Juniperus virginiana*) and hawthorns (*Crataegus* spp.) is found on the slopes of Tussey Mountain at Mussers Gap, Center County, Pennsylvania. They comprise the shrubbery growth within an old cleared area of twenty-five acres, now used for a pasture, which is surrounded by

Fig. 1. A dense growth of hawthorns as it appears in early spring.

a secondary growth of oak trees. In certain areas the hawthorns are close together and form a very dense growth, as shown in figure 1. The cedars and hawthorns are often found associated as shown in figure 4. The majority of the cedars, however, are in rather restricted groups surrounding the hawthorns. Thirteen specimens of hawthorns have been identified in this area. Several trees of *Malus glaucescens* have been found also adjacent to this

[1] Contribution from the Department of Botany. The Pennsylvania State College, No. 25.

section. Whatever the conditions, they have been very favorable for the prolific reproduction of the hawthorns and illustrate an interesting development of recognized species.

With the close association between the two hosts favorable conditions are present for the development of *Gymnosporangium* rusts. The following species are found established: *Gymnosporangium germinale* (Schw.) Kern, *Gymnosporangium globosum* Farlow, and *Gymnosporangium Juniperi-virginianae* Schw. These three species are found severely infecting the above mentioned hosts.

FIG. 2. Upper portion of a hawthorn showing the numerous hypertrofied branches as the result of infection of *G. germinale*.

The telial infection of *G. germinale* which occurs upon the trunks and branches of the cedars is most prevalent on the young growth, which is often completely girdled. On the hawthorns the most serious infection is with this rust. The young growth, modified branches, and terminal buds present abnormal hypertrofied developments when infected, as shown in figure 3. Severely infected trees with this species of rust present, from a distance, an appearance similar to a black-knot infection on

plums. Figure 2 shows the upper growth of a hawthorn in the early spring with the numerous hypertrofied branches as the result of previous infection. On the larger branches the hypertrofies indicate perennial character of the rust infection. The aecia on the branches always preceed the appearance of the aecia

FIG. 3. A branch showing the hypertrofied development of the young growth, modified branches and terminal buds as the result of infection by *G. germinale.*

on the fruit of the hawthorns. Infection with *G. germinale* on the fruit of the hawthorns is most conspicuous and the fruits are usually completely covered with the cylindrical aecia.

Infection with *G. globosum,* which occurs on the leaves of the hawthorns, has been observed to cause partial defoliation. The aecia are also commonly found developing on the calyx lobes of

the fruits. The aecia of *G. Juniperi-virginianae* were found only on the fruit and leaves of *Malus glaucescens*.

Specimens of these rusts have been collected at different times within this area by Dr. F. D. Kern, Prof. C. R. Orton and the writer. The different species of *Crataegus* have been kindly identified by Prof. W. W. Eggleston. The following list includes

FIG. 4. An intimate association between cedar and hawthorn favorable for the development of the rusts.

those species of hawthorns not previously reported as hosts in North American Flora for *G. germinale* and *G. globosum*. There are ten additional species reported for *G. germinale* and six for *G. globosum*. The remaining species of hawthorns listed includes those not previously reported for Pennsylvania.

Through the kindness of Dr. J. C. Arthur I have secured the data regarding a collection which was not reported in North American Flora, but was collected previous to our collection at Mussers Gap, Center Co., Pennsylvania. The collection is in the exsiccati of Ellis, *North American Fungi 1084,* as *Gymnosporangium germinale* on *Crataegus coccinea* collected in West Chester, Pennsylvania.

Gymnosporangium germinale (Schw.) Kern

on

Crataegus coccinea[1] L.
Crataegus coccinioides[1] *Ashe.*
Crataegus Jesupi[1] Sarg.
Crataegus macrosperma[1] Ashe.
Crataegus Margaretta[1] Ashe.
Crataegus neofluvialis[1] *Ashe.*
Crataegus pausiaca[1] Ashe.
Crataegus pruinosa[1] (Wendl.) Beadle.
Crataegus punctata[2] Jacq.
Crataegus straminea[1] Beadle.
Crataegus succulenta[1]. Schrad.

Gymnosporangium globosum Farlow

on

Crataegus Calpodendron[1] Borckh.
Crataegus coccinea[2] L.
Crataegus coccinioides[2] Ashe.
Crataegus Crus-galli[2] L.
Crataegus Jusupi[1] Sarg.
Crataegus macrosperma[1] Ashe.
Crataegus Margaretta[2] Ashe.
Crataegus neofluvialis[1] Ashe
Crataegus pruinosa[2] (Wendl.) Beadle.
Crataegus straminea[1] Beadle.
Crataegus succulenta[1] Schrad.

Gymnosporangium Juniperi-virginianae Schw.

on

Malus glaucescens[2] Rehder.

STATE COLLEGE,
PENNSYLVANIA.

[1] Species not previously reported in North American Flora.
[2] Species not previously reported from Pennsylvania.

THE FRUIT-DISEASE SURVEY

W. A. MURRILL

(WITH PLATE 3)

Encouraged by the success of the field meeting on Long Island in 1919 for the study of potato diseases, the American Phytopathological Society decided to hold a similar meeting in 1920 for the study of fruit diseases. The region selected was the Great Valley, extending from Staunton, Virginia, northward into Pennsylvania, one of the richest and best known fruit-growing districts in the United States; and the time was the first week in August, which proved to be a most fortunate selection because of the perfect weather.

Early Monday, August 2, phytopathologists began to arrive at Staunton from all parts of the country, as well as from several foreign countries, until about 75 had assembled; the attendance being further augmented by horticulturists, entomologists, and other specialists. The mornings and afternoons were devoted to inspection work and the evenings to informal discussions of the fungi causing the diseases observed and the various methods of control. No better method could be devised for meeting the problems which pathologists have to face, and, in my opinion, the meeting under discussion was the greatest in the history of plant pathology.

I have prepared a popular account of this survey for the Garden *Journal;* and Dr. G. R. Lyman, who was mainly responsible for its success, has published a brief report on it in the November number of *Phytopathology*. The following paragraph is taken from his report.

August 3 was devoted to a tour of the Staunton-Harrisonburg district in Virginia, and included the inspection of interesting demonstrations of apple root-rot and cedar rust, and comparative dusting and spraying experiments for control of various apple

diseases. The party spent August 4 in Berkeley County, West Virginia, noting the effects of cedar eradication, visiting orchards where dusting and spraying experiments were in progress, and inspecting demonstrations of collar-blight and other diseases. Visits were also made to the experimental packing plant at Inwood, and to the West Virginia pathological weather instrument station near Martinsburg. August 5 was spent in the vicinity of Hagerstown, Maryland, and was largely devoted to peach diseases and their control by dusting and spraying, some attention also being given to truck-crop diseases. On August 6, the party visited the Field Laboratory of the Pennsylvania Agricultural Experiment Station at Arendtsville, Pennsylvania, and inspected experiments in progress in that region under direction of the laboratory staff on the control of apple diseases and insects. The conference adjourned at Gettysburg, but on August 7 a portion of the party continued by automobile to Philadelphia, visiting the rich agricultural districts of Lancaster County and inspecting the tobacco experiments in progress there.

Wednesday evening, we were guests of the Chamber of Commerce of Hagerstown, Maryland. After the usual exchange of courtesies, the representatives of foreign countries were called upon for addresses, beginning with Dr. Brierly, of England; after which Dr. Ball, Assistant Secretary of Agriculture, Prof. Symons, of the University of Maryland, and other speakers entertained us until nearly midnight.

Thursday was another full day. We visited truck gardens to study blights, rots, mosaics, tip-burns, etc.; peach orchards to observe the effects of spraying; apple orchards for cedar eradication; and the Antietam battlefield for its historic interest. In the evening, there was a meeting for the discussion of local fruit diseases held under the auspices of the Washington County Fruit Growers, at which Prof. Whetzel discussed dusting and spraying, and Mr. Charles Repp, of New Jersey, outlined some of the difficulties of the commercial fruit-grower of the present day.

We shall never forget the informal talk given by Dr. Brierly in the peach orchard Thursday morning. The audience sat on a shaded, elevated terrace looking out on a wonderful valley, while

the speaker gave an immensely interesting account of the plant diseases in England. Silver-leaf was very bad on apples, plums, etc., while Nectria canker and brown-rot were among their worst orchard diseases. Potato-wart was terrible, often taking 100 per cent. of the crop. Dr. Brierly said this was the only case he knew in which the host was either entirely susceptible or entirely immune. The mycological flora of the soil was also touched upon as an exceedingly important field of investigation.

The accompanying photograph, showing a number of those in attendance, was taken at Arendtsville, Pennsylvania, after a 35-mile drive over the mountains through the Mt. Alto State Forest of 25,000 acres.

The visit to Gettysburg was greatly enjoyed, and another excellent photograph was taken which I should like to reproduce if space allowed. The effects of shot and shell on forest trees were much in evidence on the battlefield, where one white oak was noticed with 18 bullet-marks in the lower part of its trunk. In a low spot in the forest, near a spring, the white ash trees were all seriously affected with a heart-rot caused by *Fomes fraxinophilus*, many sporophores of this fungus being observed on the trunks.

The meeting Friday evening, at Gettysburg, was devoted to impressions, results, plans for the future, and a general summing-up of the phytopathological situation. Prof. C. R. Orton presided and called upon Jones, Waite, Ball, Whetzel, Brierly, Lyman, and others to make impromptu addresses on various subjects. It was the general opinion that the meeting had been a most decided success.

On Saturday morning, a number of the pathologists, including Brierly, Foëx, Rosatti, Stevenson, Bain, Whetzel, Kern, Adams, Orton, Torrey, and others, journeyed by automobile from Gettysburg to Lancaster and thence by trolley to Ephrata, where Mr. Olsen showed the co-operative experiments on tobacco being conducted by the U. S. Department of Agriculture and the Pennsylvania Agricultural Experiment Station. At the farm of Professor E. K. Hibshman, the visitors saw numerous strains of tobacco growing under the ideal conditions of this region. The

A PHOTOGRAPH TAKEN AT ARENDTSVILLE, PENNSYLVANIA

experiments included not only a tobacco strain test but also studies on various fertilizers and rotations. In connection with the field studies, difficulty has been encountered with the root-rot disease caused by *Thielavia basicola* and the plant pathologists of the Pennsylvania Agricultural Experiment Station have been called in to assist in testing the various strains of tobacco for resistance to this disease. This season, six strains were being tested on infested and noninfested soil and marked differences were noted. One strain is apparently highly resistant, though not immune, to root-rot. It will produce a good crop beside other strains which will be a total failure.

Dr. Lyman was fortunate in having such able and obliging associates on his committee of arrangements. Fromme was in charge in Virginia, Giddings in West Virginia, Temple in Maryland, and Orton in Pennsylvania. Dr. Waite represented the Department of Agriculture.

NEW YORK BOTANICAL GARDEN.

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Readers of MYCOLOGIA are invited to contribute to this department personal news items and notes or brief articles of interest to mycologists in general. Manuscript should be submitted before the middle of the month preceding the month in which this publication is issued.

Dr. C. D. Sherbakoff is now plant pathologist at the Tennessee Experiment Station.

The new officers of the Pacific Division of the Phytopathological Society are Dr. H. S. Reed, Dr. J. W. Hotson, and Dr. S. M. Zeller.

Mr. Stewart H. Burnham has removed his extensive collection of New York plants to Cornell University, where he will be permanently located.

Dr. Foëx, representing the pathologists of France, visited the Garden on September 8; and Dr. Brierly, representing those of England, spent October 8 with us and departed for Rothamsted October 9.

A memorial of the late Professor P. A. Saccardo has been prepared and distributed by Professor de Toni. Nearly half of the pamphlet of 36 pages is devoted to a list of Professor Saccardo's publications.

Professor Samuel M. Tracy died at Laurel, Mississippi, on September 5, at the age of 73. He was born at Hartford, Vermont, and educated at the Michigan Agricultural College. Several of his publications deal with the fungi, and he was associated with Professor Earle in studies of the fungous flora of the southern states.

Thomas F. Hunt, Dean of the College of Agriculture of the University of California, has accepted appointment as permanent delegate representing the United States at the International Institute of Agriculture, Rome, Italy. His wide knowledge of agricultural conditions in America, coupled with his extensive investigations in Europe, make him an exceptionally well-qualified man for this position, which has been vacant since the death of David Lubin.

Mr. Ramsbottom, general secretary of the British Mycological Society, with headquarters at the British Museum, has undertaken to compile a list of all the new genera of fungi published since the appearance of Vol. XXII of Saccardo's "Sylloge," the original diagnoses of which will appear in annual instalments in the Society's publications. He will welcome separates including descriptions of new genera or any other assistance that will make his work easier or more complete.

Dr. L. O. Overholts, of State College, Pennsylvania, arrived at the Garden, August 28, with several boxes of specimens to be studied and compared in the mycological herbarium. Among them were some specimens which we were very glad to see, including types of certain species recently described by Mr. C. G. Lloyd. Of these, *Polyporus induratus* C. G. Lloyd, collected at Urbana, Illinois, in 1918 by William McDougal, proves to be a rather thick form of *Fomes fraxineus*, which is more like the typical European specimens than most of those I have seen from America.

Grifola flavovirens was found in quantity at Yama Farms, on September 6, by several members of the Mycological Club who were out collecting fungi. It appeared in several fine clusters in a low, damp spot in oak-chestnut woods between the Inn and Jenny Brook. I have never before seen so much of this rare species in one place.

Under the title "Selecta Mycologica," in the *Annales Mycologici* for 1920, Bresadola describes 92 new species of fungi from various localities and appends a list of observations and synonyms prepared during his study of herbarium material borrowed from several European institutions.

Dr. W. H. Ballou brought to the Garden on August 30 and September 2, from White Plains, New York, a number of interesting fleshy and woody fungi which he had just collected—among them *Lactaria atroviridis*, *Lactaria Indigo*, several species of *Boletus*, a peculiar form of *Tyromyces caesius*, zygospores of *Sporodinia grandis*, and a resupinate polypore.

Pestalozzia scirrofaciens is described as new by Miss Nellie Brown in *Phytopathology* for August, 1920, as the cause of a hard tumor on the stems of the sapodilla tree in Florida. The disease can be controlled in an orchard by destroying the infected trees.

Mr. H. A. Lee, pathologist of the Bureau of Science, Manila, reports banana wilt in certain parts of the Philippine Islands. Fortunately, this disease, caused by *Fusarium cubense*, has not yet appeared upon *Musa textilis*, which yields the valuable Manila hemp of commerce.

A mosaic disease of corn in Porto Rico similar to that found on sugar-cane, is described and figured by Brandes in the *Journal of Agricultural Research* for August 16, 1920. The corn aphis is an active agent in disseminating this disease; and the only known method of control is the destruction of infected plants.

"The Ascomycetous Fungi of Human Excreta," by C. E. Fairman, issued July 30, 1920, is a small illustrated pamphlet containing historical matter, observations, a bibliography, a list of the 18 species previously known, and the description of a new species, *Cylindrocolla faecalis*, found by the author in September, 1917.

Dr. Fairman is a practising physician and became interested in these fungi because of the connection of some of them with human diseases.

Professor Bruce Fink wrote me, August 29, from Conway, Kentucky, where he spent the summer: "The woods are full of fleshy fungi, as we have had wet weather. On August 21, I picked up a strange fungus, which I suppose is a Cyclomyces. It was growing at the base of an old stump in the woods. I found one somewhat like it near here several years ago. The two are the only ones I have collected." A specimen sent for the Garden herbarium proved to be the rare *Cycloporus Greenei*, as Professor Fink suggested.

A bacterial canker of poplar, caused by *Micrococcus populi*, has become a veritable scourge in the valley of the Oise and neighboring valleys of France. It attacks the stem and branches of seedlings and the trunks of older trees. Treatments are preventive only, and include selection of stock and locality, destruction of all insects feeding on the poplar, and destruction of all diseased trees or parts of such trees.

Professor Buller has published in the *Transactions of the British Mycological Society* for September, 1920, an interesting account of the way in which the red squirrel of North America collects mushrooms and stores them up in late autumn for winter use. They are either hidden away in quantity in holes in tree trunks, in crows' nests, etc., or placed in the forks of branches, where they dry quickly and may be used when desired.

A circular on Potato Wart distributed by the U. S. Department of Agriculture in October, 1920, reviews what was previously known regarding this very serious disease and adds information recently obtained by observation and experiment. A general discussion of the subject by Lyman is followed by special discussions of susceptible varieties and new hosts contributed by Kunkel.

The disease has been found on several varieties of tomatoes. The actual damage to this new host is slight, but the fungus is kept alive and spread to new fields by this means.

The Tropical Research Laboratory of the United Fruit Company, which was formerly located at Zent, Costa Rica, and closed during the period of the war, is being reopened at Changuinola, Panama. Dr. John R. Johnston, professor of plant pathology in the University of Havana, has been appointed director of tropical research for the company with headquarters in Havana, and two pathologists will be located at the Laboratory in Panama, one to continue work on the banana disease, and the other to work on the diseases of the coconut, cacao, and other crops.

Referring to *Pucciniastrum arcticum* (Lagh.) Tranz. the statement has recently been made that "Outside of Alaska only two American collections are known." (Bull. Torr. Bot. Club **47**: 468) [Oct., 1920]. This statement needs amplifying. There are in the herbarium of the University of Wisconsin specimens representing 30 collections from upwards of 20 localities in Wisconsin ranging from the north to within about 40 miles of the southern boundary. All of these are on *Rubus triflorus* (*R. pubescens*) and all of the specimens on this species of *Rubus* are of the *arcticum* type while all of those on *Rubus strigosus* are of the *americanum* type. This raised a query as to whether the cause of the difference lay in the parasites or in the hosts.

J. J. DAVIS

"Collar-rot of Apple Trees in the Yakima Valley," by J. W. Hotson, is an important contribution to this subject published in *Phytopathology* for November, 1920. The author believes that the only essential condition of collar-rot is a permanent wound of the bark at the collar of the tree; which may be caused by *Bacillus amylovorus, Armillaria mellea, Polystictus versicolor,* gophers, frost, plowing, gradual corrosion by oxidation, etc. Where the injury is severe, the tree should be removed; in other

cases, cut out the diseased tissue, disinfect the wound with lysol and leave it exposed to the air. Bridge grafting has been tried on valuable trees, but can not be recommended as a general practice, since trees so treated are rarely thrifty.

In Bulletin 222 of the Connecticut Agricultural Experiment Station, Dr. Clinton gives an account, with illustrations, of new and unusual plant injuries and diseases found in Connecticut, 1916–1919. Under Dry Rot, on page 398, he describes a house at Westbrook, which was attacked by *Merulius lacrymans* and seriously damaged because of insufficient air drainage about the woodwork. Among the remedial measures suggested were: The removal and burning of all infected wood and rubbish; the creosoting, if possible, of the new wood used; and the building of several sunken areaways, protected only by wire netting, to allow free access of air under the house. According to Dr. Clinton, the dry-rot fungus depends in great measure for its development upon a fairly small and tightly closed air space next the wood, and a sufficient amount of water to keep the air therein constantly saturated or at least above the normal amount.

The results of experimental work and observations on the citrus canker by Peltier and Frederich are published in the *Journal of Agricultural Research* for July 15, 1920. The following statements are quoted from the summary:

The successful inoculation of a large number of wild relatives in the greenhouse shows that *Pseudomonas citri* has a wide range of hosts and is not limited to the genus *Citrus*.

So far as the menace of citrus-canker to the citrus industry of the United States is concerned, with the exception of *Poncirus trifoliata*, none of the wild relatives, native or introduced, now growing in the citrus districts are susceptible enough to have any bearing on the eradication program.

Leaf texture is apparently an important factor in influencing resistance to *Pseudomonas citri* by its host plants. This phase deserves further investigation.

An exceedingly important discussion of sugar-cane root disease by Earle and Matz appeared in the *Journal of the Department of Agriculture of Porto Rico* for January, 1920. A summary of the situation in Porto Rico is given by Earle, as follows:

> Root disease as here understood is a complex including phases often known as Root Rot, Wither Tip, Top Rot and Rind Disease. These phenomena are caused by a number of facultative parasites, none of which attack actively growing vigorous tissues. There is also a heretofore unknown true parasite inhabiting the vascular bundles. *Rhizoctonia* and *Pythium* are the usual root-killing agents rather than *Marasmius* and *Himantia*.
>
> Cane varieties differ greatly in their resistance or susceptibility to Root Disease. The Otaheite or Cana Blañca is very susceptible. North Indian canes like Kavangire and those with part North Indian parentage are very resistant or practically immune.
>
> Remedial or preventive measures include
>
> *A.* The planting of resistant varieties.
>
> *B.* Better cultural methods to overcome facultative parasites.
>
> *C.* Proper seed selection and handling.

The parasite inhabiting the vascular bundles is described by Matz as *Plasmodiophora vascularum.* It is said to differ from *P. brassicae* in having larger spores, in not forming galls, and in inhabiting the vascular system of its host, plugging up the conducting vessels and greatly interfering with their action.

A New Bolete from Porto Rico

Gyroporus Earlei sp. nov.

Pileus broadly convex, solitary, 8–10 cm. broad; surface slightly viscid when young, becoming dry at maturity, subglabrous, fulvous; margin thin, concolorous; context fleshy, firm, yellowish-white, unchanging, taste mild, but slightly mawkish; tubes sinuate-depressed, minute, ochraceous at maturity, not stuffed when young; spores ovoid to ellipsoid, smooth, honey-yellow under the microscope, with a very large nucleus, $7–8 \times 4–5\,\mu$; stipe somewhat enlarged above and below, bright-yellow at the apex, otherwise very dark brown, almost black, glabrous, solid, firm, 5 cm. long, 1.5–2 cm. thick.

Type collected in sandy land beside a ditch in an old grape-fruit grove,—where the trees were dying from root disease,—near Manati, Porto Rico, October 29, 1920, *F. S. Earle.* The description is largely drawn from field-notes accompanying the collec-

tion. Boletes are exceedingly rare in tropical regions. This is probably the first specimen of the group that has been found in Porto Rico; and it is interesting to note that it belongs to the small genus having pale, ellipsoid spores.

W. A. MURRILL.

Tree Surgery is the subject of Farmers' Bulletin 1173, by J. Franklin Collins, published in September, 1920. This bulletin is intended primarily as a guide for those who desire to take care of their own trees or to superintend such work. It outlines some of the better methods of treating injuries, removing dead or diseased limbs, and repairing decayed spots in the trunk or limbs.

A badly diseased or injured tree should be removed and replaced by a healthy one unless there is some very special reason for trying to preserve the tree. This applies particulary to an old tree that has been in poor condition or in poor soil for some years. Such a tree rarely recovers completely from the shock of extensive or elaborate repair work on the trunk; in fact, it often deteriorates more rapidly thereafter. Two axioms of tree-repair work (tree surgery) that should be borne in mind constantly are (1) that prompt treatment of freshly made wounds is the surest and most economical method of preventing disease or decay in the future and (2) that all wounds made in tree-surgery work should be cleaned, sterilized, and protected from infection just as thoroughly as in the case of animal surgery and for exactly the same reasons.

At present tree-repair work has not received the recognition and approval from tree owners that it deserves. This may be due at times to unfavorable experiences with dishonest and ignorant tree surgeons, at other times to the reluctance of the owners to spend much money in preserving their trees, or from their ignorance of the benefits that may result when tree-repair work is properly done. Reliable tree surgeons are doing much in a practical way to educate the public as to the benefits of tree-repair work. Unfortunately, the unscientific or dishonest work of some others still is doing much to offset it.

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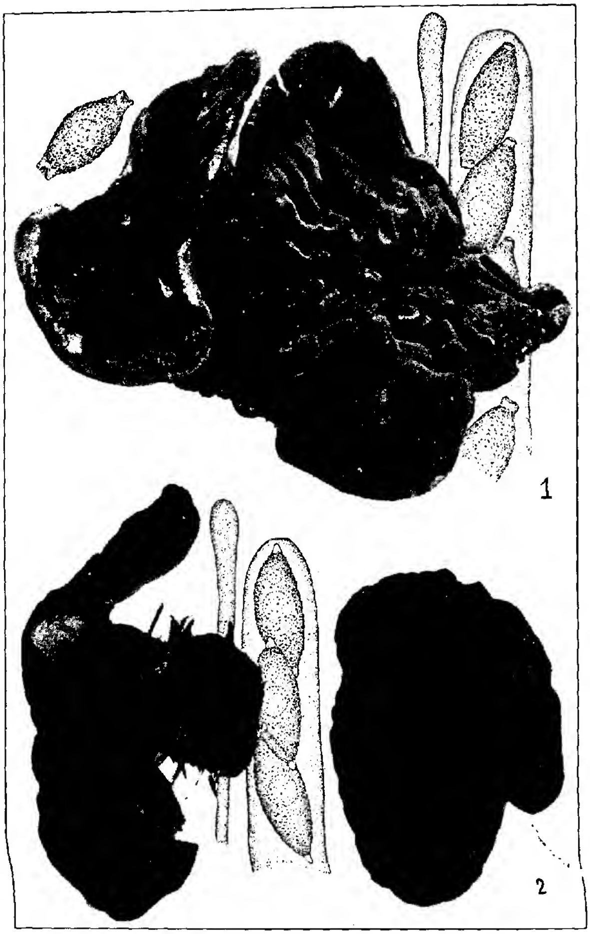

1. Discina convoluta Seaver
2. Discina ancilis (Pers.) Sacc.